1989

Otoe County Test Hole Logs

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OTOE COUNTY
Test-Hole Logs

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Nebraska Water Survey
Test-Hole Report No. 66

Conservation and Survey Division
Institute of Agriculture and Natural Resources
University of Nebraska—Lincoln

December 1989

The Conservation and Survey Division of the University of Nebraska is the agency designated by statute to investigate and interpret the geologically related natural resources of the state, to make available to the public the results of these investigations, and to assist in the development and conservation of these resources.

The division is authorized to enter into agreements with federal agencies to engage in cooperative surveys and investigations in the state. Publications of the division and the cooperating agencies are available from the Conservation and Survey Division, University of Nebraska, Lincoln, Nebraska 68588-0517.

The Conservation and Survey Division provides information and educational programs to all people without regard to race, color, national origin, sex or handicap.

Publication and price lists are furnished upon request.

December 1989

ACKNOWLEDGMENTS

The authors gratefully acknowledge the contributions of the following Conservation and Survey Division personnel for production of this test-hole log book: Duane Mohlman and Ann Harding for typing, compiling and updating the logs and Jerry Leach for drafting the illustrations.

INTRODUCTION

In 1930, the Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey began a program of cooperative groundwater studies in Nebraska. Since then test drilling by use of rotary drilling equipment has been an integral part of that program. This report contains logs of all the test holes drilled in the county under the program as well as those drilled by the Conservation and Survey Division with financial assistance from other government agencies.

The map in this report shows the location of all test holes drilled in the county since 1930.

Present techniques of test-hole logging and sampling include use of drilling mud suitable to drilling conditions, timing by stopwatch of the drilling of each 5-foot increment of depth, and removal of all cuttings from the test hole at intervals of 5 feet or less. During the drilling of the hole, cuttings from each interval are examined immediately; samples representing each 5-foot interval and each recognizable change in material are retained. After samples are washed, they are described lithologically and the color is evaluated by comparison with standard color charts. The samples then are dried, stored, and cataloged. Beginning in September 1951, the test holes have been logged electrically. All samples are processed and kept on open file in the offices of Conservation and Survey Division, 113 Nebraska Hall, University of Nebraska-Lincoln, 68588.

This publication is one of a series being issued to make more readily available the record of test holes drilled since 1930. The series of publications is made on a county basis and includes, with some exceptions, logs of all test holes drilled in each of the counties. The logs have not been reviewed for conformance with editorial standards and nomenclature.

The method whereby the altitude of the land surface at test-hole sites was determined is indicated in the heading of each log, as follows: a = altimeter, h = hand leveling, i = spirit leveling, t = estimated from topographic map.

The test-hole records accurately reflect subsurface conditions only at the locations where the test holes were drilled. Interpretive data reflecting probable subsurface conditions between test-holes are being compiled for publication in county reports and are available for inspection in the office of the Conservation and Survey Division.

Each test hole is identified by a number assigned in the field (for example #3-B-67, #41-79), and most are also identified by a number indicating its location within the land divisions of the U.S. Bureau of Land Management's survey of Nebraska. Location numbers of test holes east of the 6th principal meridian, which passes through Columbus in a north-south direction, are preceded by the capital letter A; those west of the principal meridian have no preceding letter. The first numeral indicates the township, the second the range, and the third the section. As shown in figure 1, the letters that follow the section number indicate the location of the test hole within the section, the first letter indicating the quarter section and the second letter indicating the quarter-quarter section. The letters A, B, C, and D are applied in counterclockwise direction beginning with A in the northeast quadrant. The last numeral is the serial number of the test hole within the quarter-quarter section. No number is shown unless more than one test hole is within the given quarter-quarter section.

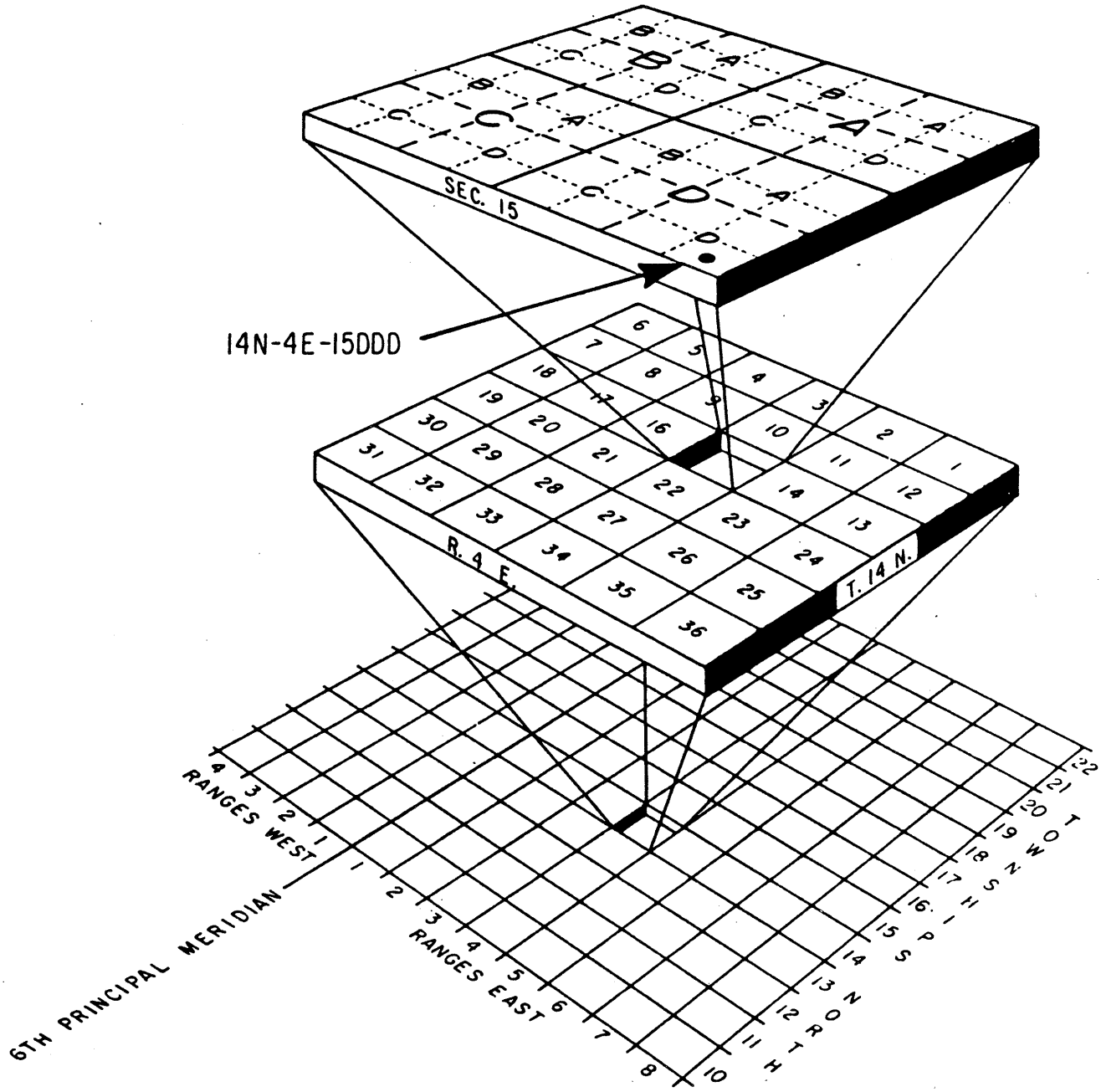

Fig. 1. System for identifying test-holes according to their location.

OTOE COUNTY

Test-hole logs are arranged in this publication by township, range and section, and figure 2 shows a location map of these test-holes in Otoe County.

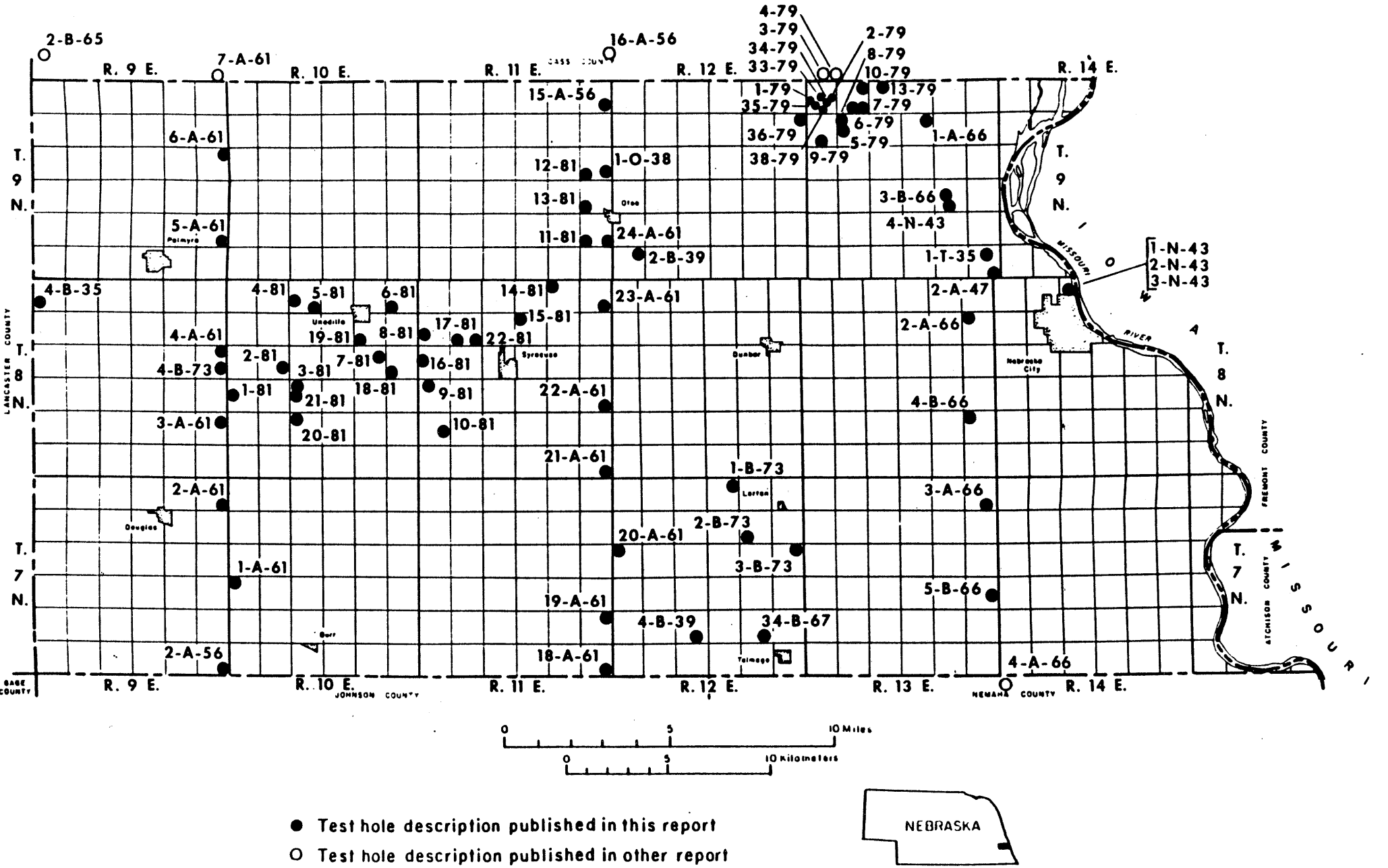

Fig. 2. Test-hole location map for Otoe County.

Test Hole #2-A-61
Otoe County

Location: SE corner sec. 1, T. 7 N., R. 9 E., approximately 113 feet north of south section line and 17 feet west of east section line.
Ground elevation: 1,274.3 ft. (Burr 7.5 min. quadrangle)
Depth to water: 7.31 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Clay, silty, light olive gray, some limy grains.....	0.0	0.5
Clay, silty, light brownish gray, below 2.5 ft., grayish brown.....	0.5	5.5
Silt, moderately clayey, dark brown, from 7.5 to 10.0 ft. very clayey, dark reddish brown.....	5.5	10.0
Clay, silty, slightly sandy, reddish brown, sand is very fine to fine, below 13.0 ft. brownish yellow, moderately sandy.....	10.0	16.7
Till: clay, silty, sandy to gravelly, light yellowish brown.....	16.7	17.5
Sand and gravel, fine sand to fine gravel, silty....	17.5	19.5
Till: clay, silty, sandy to gravelly, yellowish brown, some brown, some limy grains, below 35.5 ft. dark gray with greenish tint.....	19.5	47.0
Silt, moderately clayey, sandy, dark gray, sand is very fine, below 47.8 ft. very clayey, olive.....	47.0	49.5
Till: clay, silty, sandy, gravelly, moderately calcareous, dark gray, some limy grains.....	49.5	51.4
Permian System - Big Blue Series - Council Grove Group:		
Stearns Formation:		
Shale, pale yellow mottled with dark yellowish orange, slightly calcareous.....	51.4	53.1
Shale, pale yellow, clay to silt, hard, celestite...	53.1	55.0
Shale, light gray, slightly calcareous, hard with some limy material.....	55.0	57.0
Beattie Formation:		
Cottonwood Member:		
Limestone, light gray mottled with pale yellow, very finely crystalline to dense, and light gray, finely crystalline with fossil fragments.....	57.0	60.0
Limestone, pale yellowish gray, finely crystalline, vesicular, contains fusulinids and white chert....	60.0	68.0
Limestone, dark gray, finely crystalline, contains "algal looking material".....	68.0	70.8
Eskridge Formation:		
Shale, pale yellow, moderately calcareous.....	70.8	71.5
Shale, pale olive, moderately calcareous.....	71.5	75.0
Shale, light gray, moderately calcareous.....	75.0	80.0
Limestone, light brown, finely crystalline, contains fossil fragments.....	80.0	81.0
Shale, pink, moderately calcareous.....	81.0	85.0
Shale, pale olive gray, moderately calcareous.....	85.0	87.0

Limestone, medium gray, finely crystalline, contains fossil fragments, "black inclusions" and selenite.	87.0	88.7
Shale, light greenish gray, moderately calcareous...	88.7	92.0
Shale, dark reddish brown, slightly calcareous with seams of light greenish gray mottled with red from 92.0 to 93.5 ft., from 94.7 to 95.9 ft., from 97.5 to 98.5 ft., and from 101.5 to 101.7 ft.....	92.0	107.0
Shale, light greenish gray, slightly sandy, very finely micaceous, slightly calcareous.....	107.0	109.5
Grenola Formation:		
Neva Member:		
Limestone, light gray, stained red in part, very finely crystalline, with some light gray, finely crystalline, contains calcite and fossil fragments	109.5	110.0

Test Hole #2-A-56
(A7-9-36dd)
Otoe County

Location: NE corner SE SE SE sec 36, T. 7 N., R. 9 E., approximately 550 feet north and 6 feet west of southeast corner.
Ground elevation: 1,243.0 ft. (Burr 7.5 min. quadrangle)
Depth to water: 84.0 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	1.0
Silt, moderately clayey, slightly sandy, light brown and light brownish gray, contains very fine to fine sand, contains a trace of coarse sand to gravel below 5.0 ft., very sandy, light yellowish brown below 5.6 ft	1.0	7.0
Till: silt, very clayey, slightly sandy to pebbly, moderately calcareous, light and medium yellowish gray, some mottled light brown, dark brown and light gray	7.0	31.7
Coarse silt to very fine sand, interbedded, slightly calcareous	31.7	35.6
Limy nodular layer and clayey silt	35.6	37.0
Sand, quartz with green and some dark silicates, iron stained, texture grades from very fine to fine with some medium and a trace of coarse sand, texture grades from very fine to medium with a trace of coarse below 45.0 ft., contains thin clay layers at 52.0 and 53.0 ft	37.0	55.5
Silt, slightly clayey, slightly sandy, in part very sandy, light yellowish gray, contains very fine sand	55.5	62.0
Sand, texture grades from very fine to medium, fine to medium with some very fine and a little coarse sand from 70.0 to 75.0 ft., medium to very coarse with a trace of fine gravel from 75.0 to 85.0 ft., fine to very coarse below 85.0 ft., slightly iron stained from 75.0 to 77.0 ft. and from 80.0 to 85.0 ft	62.0	88.0
Sand and gravel, very iron stained, texture grades from coarse sand to fine gravel with a trace of medium gravel, contains many limestone grains	88.0	90.0
Sand, moderately iron stained, texture grades from fine to very coarse with a little fine to medium gravel	90.0	91.0
Till: silt, slightly clayey, moderately sandy, in part very sandy, moderately calcareous, yellowish gray, very clayey, slightly sandy below 94.5 ft., olive gray from 94.5 to 95.0 ft., medium gray below 95.0 ft	91.0	100.2
Sand and gravel, quartz with many limestone grains	100.2	100.8

Till: silt, very clayey, slightly sandy, moderately calcareous, medium gray, very sandy from 118.0 to 118.5 ft.....	100.8	128.5
Sand and gravel, quartz and dark silicates, many limestone grains, texture grades from medium sand to fine gravel, contains very sandy till layer from 129.5 to 129.8 ft.....	128.5	130.1
Till: silt, very clayey, slightly to moderately sandy, moderately calcareous, medium gray, contains quartzite boulder from 132.5 to 133.0 ft....	130.1	135.0
Till, very sandy and sand, interbedded, moderately calcareous, medium gray.....	135.0	138.0
Till: silt, very clayey, moderately sandy, moderately calcareous, medium gray.....	138.0	139.8
Sand, many limestone grains, texture grades from fine to very coarse sand with some fine gravel, contains very sandy till layer from 141.0 to 141.7 ft., and a boulder from 142.8 to 143.2 ft.....	139.8	143.2
Silt, moderately clayey, slightly sandy, light to medium gray, contains very fine sand, moderately sandy, slightly calcareous, contains very fine to fine sand below 156.0 ft.....	143.2	159.0
Silt, very clayey, slightly sandy, light to medium brownish gray, contains very fine sand, light to medium yellowish gray from 165.0 to 166.5 ft., medium brownish gray from 166.5 to 169.0 ft.....	159.0	173.0
Clay, silty, light to medium brownish gray.....	173.0	173.5
Silt, moderately clayey, in part very clayey, light to medium brownish gray, moderately sandy, contains very fine to fine with a trace of medium sand below 198.0 ft., contains a few small limy nodules from 175.0 to 180.0 ft. and from 184.0 to 188.5 ft. and below 190.0 ft., light to medium yellowish gray from 175.0 to 178.0 ft., slightly calcareous below 178.0 ft., light to medium gray from 190.0 to 197.0 ft., light gray below 197.0 ft., some white limy areas from 184.0 to 185.0 ft.	173.5	199.2
Sand, principally quartz with pink and green silicates, texture grades from very fine to coarse....	199.2	210.0
Sand and fine gravel, quartz with pink silicates, contains cemented sand and gravel or limestone boulder from 215.9 to 217.0 ft., non- to very calcareous.....	210.0	218.0
Permian System - Big Blue Series - Admire Group:		
Shale, clayey, slightly calcareous, yellowish brown, medium gray below 218.3 ft., contains thin shaly limestone layers, very light gray from 219.0 to 219.7 ft.....	218.0	221.0
Limestone, very calcareous, white, contains a trace of pyrite, dense.....	221.0	221.5

Test Hole #1-A-61
Otoe County

Location: NE NW NW sec. 19, T. 7 N., R. 10 E., approximately 440 feet south of north section line and 1,050 feet east of west section line.
Ground elevation: 1,162.2 ft. (Burr 7.5 min. quadrangle)
Depth to water: 8.08 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Silt, slightly clayey, dark gray, below 3.5 ft. very dark grayish brown	0.5	4.5
Silt, moderately clayey, very dark brown, below 5.0 ft. very clayey, dark gray	4.5	7.5
Clay, silty, dark grayish brown, some iron stain, brown to yellowish brown below 8.3 ft	7.5	18.4
Silt, very sandy, moderately clayey, grayish brown, sand is very fine	18.4	20.2
Gravel, sandy, fine sand to coarse gravel	20.2	27.4
Permian System - Big Blue Series - Council Grove Group:		
Roca Formation:		
Shale, light grayish green, very slightly calcareous	27.4	31.3
Limestone, pale yellow, fine grained, soft	31.3	32.6
Shale, light greenish gray, very slightly calcareous	32.6	33.0
Shale, as above but sandy and very finely micaceous.	33.0	34.2
Shale, light reddish brown, very slightly calcareous	34.2	36.0
Shale, light gray mottled with light reddish brown..	36.0	36.5
Limestone, pale yellow, fine grained, soft	36.5	37.4
Shale, light gray, slightly sandy, non-calcareous...	37.4	38.3
Shale, light greenish gray, mottled with dark reddish brown	38.3	38.6
Red Eagle Formation:		
Howe Member:		
Limestone, light gray, very finely crystalline to dense, contains calcite stringers, some interbedded shale	38.6	40.0
Limestone, light brown, very finely crystalline to dense, vuggy, much interbedded light grayish green shale	40.0	41.8
Limestone, pale yellow, fine grained, soft and as above	41.8	45.0
Bennett Member:		
Shale, pale yellow, mottled with limonite color, moderately calcareous	45.0	48.8
Shale, medium gray, slightly calcareous	48.8	53.0
Shale, black, non-calcareous	53.0	53.1
Shale, light gray, moderately calcareous, pyrite	53.1	54.6
Shale, black, non-calcareous	54.6	55.0
Shale, dark gray, moderately calcareous	55.0	55.8

Glenrock Member:		
Limestone, light bluish gray, irregularly crystalline, contains fusulinids replaced with calcite...	55.8	56.8
Johnson Formation:		
Shale, light gray, slightly calcareous.....	56.8	58.1
Shale, light grayish green, moderately calcareous with some light gray, very fine grained sandstone.	58.1	65.0
Shale, medium gray, very slightly calcareous.....	65.0	65.5
Shale, light greenish gray, and as above.....	65.5	67.1
Foraker Formation:		
Long Creek Member:		
Limestone, white, fine grained to very finely crystalline, contains fossil fragments and much interbedded light greenish gray shale.....	67.1	73.8
Hughes Creek Member:		
Shale, light greenish gray with limestone as above..	73.8	75.0
Shale, medium gray, slightly calcareous.....	75.0	79.7
Shale, as above with limestone, dark gray, finely crystalline, contains pyrite, spines, fossil fragments and "algal looking material".....	79.7	80.0

Test Hole #19-A-61
Otoe County

Location: NE corner sec. 25, T. 7 N., R. 11 E., approximately 4 feet south of north section line and 454 feet west of east section line.
Ground elevation: 1,070.5 ft. (Talmage 7.5 min. quadrangle)
Depth to water: 56.8 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Silt, slightly clayey, dark brown, below 2.9 ft. brown	0.5	6.0
Silt, slightly clayey, brown, some dark staining, below 12.5 ft. dark grayish brown	6.0	13.0
Silt, moderately clayey, dark brown, below 15.0 ft. brown, below 20.0 ft. contains trace of very fine sand	13.0	27.6
Silt, moderately clayey, yellowish brown, contains some very fine to fine sand, below 30.0 ft. sand is very fine to medium, below 35.7 ft. pale brown.	27.6	40.3
Silt, moderately clayey, sandy, pale yellow, sand is very fine to medium, some coarse	40.3	45.0
Silt, moderately clayey, sandy, light brownish gray, sand is very fine to medium, some dark staining	45.0	56.0
Silt, moderately clayey, sandy, pale yellow, sand is very fine, some dark staining, from 60.0 to 61.8 ft. light brownish gray, below 61.8 ft. gray	56.0	62.0
Sand, gravelly, fine sand to medium gravel, trace of coarse gravel	62.0	74.0
Silt, moderately clayey, sandy, light olive gray, sand is very fine, some iron stain, below 78.5 ft. dark grayish brown	74.0	79.0
Silt, moderately clayey, sandy, dark bluish gray, sand is very fine	79.0	82.0
Silt, moderately clayey, sandy, grayish brown, sand is very fine, below 83.5 ft. very sandy, light brownish gray, sand is very fine to fine	82.0	85.0
Sand, very fine to medium, trace of coarse to very coarse, rare gravel	85.0	90.0
Sand, gravelly, medium sand to fine gravel, below 95.0 ft. limy areas and reworked materials	90.0	98.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Soldier Creek Formation:		
Shale, light tan	98.0	99.5
Shale, dark reddish brown	99.5	100.0
Burlingame Formation:		
South Fork Member:		
Limestone, pale yellow, irregularly crystalline, iron stained	100.0	101.8
Winnebago Member:		
Shale, light greenish gray	101.8	102.0

Shale, dark reddish brown and light greenish gray...	102.0	102.9
Shale, dark reddish brown.....	102.9	107.5
Shale, dark reddish brown and light greenish gray...	107.5	108.2
Shale, light greenish gray and dark reddish brown...	108.2	108.8
Shale, medium olive.....	108.8	108.9
Shale, medium gray and dark gray.....	108.9	116.4
Taylor Branch Member:		
Limestone, light gray, very finely crystalline.....	116.4	118.5
Shale, light greenish gray and light gray.....	118.5	119.9
Limestone, light tan weathers white, finely crystalline, "granular looking".....	119.9	121.9
Scranton Formation:		
Shale, light greenish gray.....	121.9	122.5
Shale, dark reddish brown and light greenish gray...	122.5	122.8
Shale, medium olive.....	122.8	124.5
Shale, medium gray.....	124.5	130.7

Test Hole #18-A-61
Otoe County

Location: SE corner SE sec. 36, T. 7 N., R. 11 E., approximately 9 feet north of south section line and 155 feet west of east section line.
Ground elevation: 1,026.0 ft. (Talmage 7.5 min. quadrangle)
Depth to water: 10.75 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Silt, moderately clayey, dark gray	0.5	5.7
Clay, silty, dark gray, some iron stain, from 6.3 to 7.1 ft. grayish brown, below 7.1 ft. yellowish brown	5.7	8.3
Silt, moderately clayey, slightly calcareous, brownish yellow to light gray, some limy nodules and iron stain	8.3	10.8
Silt, slightly clayey, light brownish gray, some iron stain, below 15.0 ft. sandy, sand is very fine to fine	10.8	18.0
Sand, silty, very fine to fine	18.0	20.0
Sand, gravelly, medium sand to medium gravel	20.0	30.0
Gravel, sandy, medium sand to medium gravel	30.0	37.0
Silt, moderately clayey, slightly sandy, moderately calcareous, bluish gray	37.0	39.2
Clay, silty, moderately calcareous, bluish gray	39.2	45.0
Sand, fine to coarse, some very coarse, below 50.0 ft. some fine to medium gravel	45.0	51.1
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Burlingame Formation:		
Winnebago Member:		
Shale, dark reddish brown, very slightly calcareous.	51.1	51.6
Shale, medium yellowish gray, very slightly calcareous	51.6	53.7
Shale, medium gray, very slightly calcareous	53.7	59.0
Shale, dark gray	59.0	59.9
Taylor Branch Member:		
Limestone, dark gray, finely crystalline, shaly, contains spines, brachiopod fragments, pyrite	59.9	60.4
Limestone, light gray, very finely crystalline	60.4	61.7
Shale, light greenish gray, slightly sandy, and limestone, as above	61.7	62.0
Shale, as above, stained pink in part	62.0	62.5
Limestone, light brown, finely crystalline, "granular looking", sandy, weathers white	62.5	65.7
Limestone, as above but shaly and interbedded light greenish gray shale	65.7	67.0
Scranton Formation:		
Shale, light greenish gray	67.0	67.7
Shale, medium gray	67.7	70.7

Test Hole #1-B-73
Otoe County

Location: NE SE NE NE sec. 3, T. 7 N., R. 12 E., approximately 834 feet south of north section line and 12 feet west of east section line.
Ground elevation: 1,085.5 ft. (Talmage 7.5 min. quadrangle)
Depth to water: 1.5 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	2.5
Clay, silty, slightly sandy, light brownish gray, from 6.0 to 8.0 ft. medium gray, below 8.0 ft. light brown	2.5	16.2
Clay, silty, sandy, pinkish gray, below 20.0 ft. brown, below 22.0 ft. sandy	16.2	28.0
Clay, silty, sandy, light olive, some red and yellow, from 30.0 to 31.2 ft. brown with some red, below 31.2 ft. gray, in part some yellow	28.0	44.0
Sand, fine to coarse	44.0	45.0
Sand, slightly gravelly, fine sand to fine gravel, from 50.0 to 54.0 ft. interbedded clay layer	45.0	60.0
Silt, moderately clayey, moderately sandy, light gray, sand is very fine to medium	60.0	62.0
Silt, moderately clayey, dark gray, below 66.0 ft. light gray, slightly sandy	62.0	70.5
Silt, moderately clayey, moderately sandy, red with some gray	70.5	72.5
Sand, very fine to fine	72.5	73.4
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, pale red, very finely micaceous, sandy	73.4	75.0
Shale, light greenish gray, very finely micaceous, sandy	75.0	76.1
Shale, pale olive, sandy, very finely micaceous	76.1	79.7
Shale, light gray	79.7	89.3
Wakarusa Formation:		
Limestone, light gray, very finely crystalline, contains crinoids	89.3	92.2
Soldier Creek Formation:		
Shale, gray	92.2	95.3
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, finely crystalline with interbedded greenish gray shale	95.3	96.5
Winnebago Member:		
Shale, reddish brown	96.5	97.2
Shale, gray with interbedded limestone	97.2	98.0
Shale, reddish brown with interbedded limestone	98.0	100.0
Limestone, gray with interbedded red and gray shale.	100.0	100.5
Shale, light gray, micaceous	100.5	101.5
Shale, reddish brown	101.5	106.0

Shale, gray, clayey	106.0	116.5
Taylor Branch Member:		
Limestone, gray, very finely crystalline, contains some black inclusions	116.5	120.0
Scranton Formation:		
Shale, greenish gray	120.0	121.1
Shale, brown, clayey	121.1	122.7
Shale, gray, clayey	122.7	129.0
Shale, black with interbedded limestone	129.0	135.7
Shale, reddish gray	135.7	136.6
Shale, greenish gray, clayey	136.6	138.4
Shale, reddish brown	138.4	140.5
Shale, reddish brown with some interbedded limestone	140.5	143.6
Shale, brown	143.6	144.9
Shale, greenish gray	144.9	145.8
Shale, brown	145.8	146.0
Limestone, gray with interbedded greenish gray shale	146.0	147.3
Shale, gray, clayey	147.3	153.6
Coal	153.6	153.8
Shale, gray, clayey	153.8	170.0
Shale, gray with some interbedded limy seams	170.0	180.0
Shale, gray, clayey, contains pyrite	180.0	200.0
Shale, gray, sandy	200.0	205.9
Shale, dark gray, sandy	205.9	208.1
Shale, gray with interbedded sandstone, contains pyrite	208.1	211.5
Howard Formation:		
Limestone, gray, very finely crystalline	211.5	216.0
Limestone, dark gray, very fine crystalline with interbedded dark gray shale	216.0	216.7
Severy Formation:		
Shale, black	216.7	218.0
Shale, gray	218.0	220.0
Shale, dark gray	220.0	223.5
Shale, black, fissile	223.5	223.9
Shale, dark gray	223.9	226.8
Limestone, light gray, very finely crystalline	226.8	227.7
Shale, dark gray	227.7	229.4
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, gray, very finely crystalline	229.4	230.0
Limestone, dark gray, very finely crystalline, contains crinoids and brachiopods	230.0	235.0
Holt Member:		
Shale, dark gray and black carbonaceous	235.0	235.7
DuBois Member:		
Limestone, dark gray, finely crystalline, contains brachiopods and crinoids	235.7	236.9
Turner Creek Member:		
Shale, greenish gray	236.9	239.1
Sheldon Member:		
Limestone, light gray, finely crystalline	239.1	240.0

Test Hole #2-B-73
Otoe County

Location: SW SW SW SW sec. 11, T. 7 N., R. 12 E., approximately 246 feet north and 11 feet east of southwest corner.
Ground elevation: 1,073.5 ft. (Talmage 7.5 min. quadrangle)
Depth to water: 23.0 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
No sample	0.0	0.5
Soil: clay, dark grayish brown	0.5	1.0
Silt, very clayey, yellowish brown	1.0	6.5
Clay, slightly silty, reddish yellow, from 8.8 to 15.0 ft. light gray, below 15.0 ft. pale brown, below 20.0 ft. in places some gravel grains	6.5	30.5
Clay, silty, slightly sandy, pale brown, sand is very fine to very coarse	30.5	40.0
Sand, very silty, sand is very fine to coarse	40.0	43.0
Clay, silty, slightly sandy with bone fragments to 50.7 ft., mottled grayish brown and yellow	43.0	56.0
Clay, silty, red with some gray to 57.3 ft., below 57.3 ft. slightly sandy, gray, sand is very fine to fine	56.0	64.0
Sand, silty, sand is very fine to fine	64.0	66.0
Clay, silty, reddish brown, below 68.1 ft. gray, below 75.0 ft. sandy, sand is very fine to coarse, from 95.1 to 95.4 ft. limy	66.0	99.0
Clay, silty, grayish brown	99.0	102.8
Clay, silty, dark grayish black, from 105.0 to 107.5 ft. medium gray, below 107.5 ft. sandy, sand is very fine	102.8	115.2
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Siltstone, light gray with interbedded gray shale	115.2	116.3
Shale, pale olive	116.3	117.2
Shale, gray	117.2	120.0
Shale, gray with interbedded reddish brown shale	120.0	135.0
Shale, greenish gray	135.0	140.0
Limestone, light gray with interbedded greenish gray shale	140.0	141.3
Shale, greenish gray	141.3	143.9
Shale, dark greenish gray, sandy	143.9	150.0
Shale, dark greenish gray with interbedded reddish brown shale	150.0	165.0
Shale, red with yellow and greenish gray mottling	165.0	170.0
Shale, medium to dark gray	170.0	180.8
Limestone, gray with brown staining	180.8	181.0
Shale, light greenish gray, limy, contains limestone lenses	181.0	183.0
Shale, dark greenish gray	183.0	184.0
Limestone, medium to dark gray, contains brachiopods and crinoids	184.0	189.0

Shale, gray with interbedded brown shale.....	189.0	189.6
Shale, light gray.....	189.6	189.8
Shale, black, fissile.....	189.8	190.5
Shale, dark gray.....	190.5	195.8
Shale, black, fissile, hard.....	195.8	196.2
Shale, gray.....	196.2	198.8
Shale, light gray.....	198.8	200.0

Test Hole #3-B-73
Otoe County

Location: NE NE NW NE sec. 13, T. 7 N., R. 12 E., approximately 7 feet south of north section line and 1,464 feet west of east section line.
Ground elevation: 1,034.5 ft. (Talmage 7.5 min. quadrangle)
Depth to water: 13.0 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Clay, silty, light brown, below 0.9 ft. dark brown	0.5	6.5
Silt, clayey, light brown	6.5	18.0
Clay, very silty, sandy, light gray, sand is fine to coarse	18.0	20.0
Sand, very fine to coarse	20.0	21.8
Sand, gravelly, very fine sand to coarse gravel, below 28.0 ft. some clay lenses	21.8	40.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Pillsbury - Stotler Formations:		
Shale, greenish gray	40.0	45.0
Shale, greenish gray with interbedded siltstone, contains some organic matter	45.0	50.9
Sandstone, dark gray, very fine to fine grained, micaceous, contains some organic matter, hard	50.9	51.6
Shale, gray with interbedded siltstone	51.6	65.0
Shale, gray, clayey	65.0	70.7
Zeandale Formation:		
Maple Hill Member:		
Limestone, dark gray, very finely crystalline, fossiliferous, contains brachiopods and pyrite	70.7	72.4
Wamego Member:		
Shale, dark gray, micaceous with thin interbedded siltstone lenses	72.4	74.1
Tarkio Member:		
Shale, black, organic with interbedded thin limestone	74.1	74.4
Shale, medium to dark gray	74.4	75.9
Limestone, brownish gray, very finely crystalline, fossiliferous, contains crinoids and interbedded light brown shale	75.9	77.7
Limestone, light gray, very finely crystalline, silty	77.7	78.0
Shale, gray mottled with greenish gray tint	78.0	79.0
Shale, gray with purple tint	79.0	79.9
Limestone, tannish gray, moderately fossiliferous, contains crinoids	79.9	81.0
Shale, pink and greenish gray interbedded limestone	81.0	82.0
Limestone, greenish gray, fossiliferous with interbedded greenish gray shale, contains fusulinids	82.0	83.8
Willard Formation:		
Shale, greenish gray, dark gray and yellow	83.8	85.0

Shale, greenish gray with interbedded reddish brown and yellow shale	85.0	87.0
Shale, greenish gray with interbedded dark gray, contains pyrite	87.0	89.0
Shale, dark gray to gray, contains pyrite with black carbonaceous streaks	89.0	90.7
Shale, dark gray	90.7	94.4
Shale, gray, very fine grained	94.4	95.6
Shale, dark gray, contains a trace of pyrite	95.6	99.0
Shale, dark gray, contains pyrite and black streaks.	99.0	100.0
Shale, dark gray with light gray mottling, sandy from 3.5 to 5.0 ft., contains trace of black shale	100.0	115.2
Limestone, gray, finely crystalline	115.2	115.9
Shale, dark gray	115.9	120.0
Shale, dark gray with brownish tint	120.0	122.5
Shale, dark gray	122.5	123.8
Limestone, greenish gray, finely crystalline, with interbedded greenish gray shale	123.8	125.0
Shale, gray	125.0	126.6
Shale, reddish brown, sandy	126.6	129.0
Limestone, white, finely crystalline, with interbedded red shale	129.0	130.0
Shale, reddish gray	130.0	133.3
Shale, greenish gray	133.3	134.1
Shale, reddish gray with interbedded greenish gray shale	134.1	135.3
Shale, greenish gray	135.3	135.7
Limestone, gray, very finely crystalline	135.7	136.4
Shale, greenish gray	136.4	137.0
Emporia Formation:		
Elmont - Reading Members:		
Limestone, gray, very finely crystalline, with interbedded shale, contains brachiopods	137.0	139.6
Shale, dark gray	139.6	141.1
Limestone, light gray, very finely crystalline, contains brachiopods and crinoids	141.1	145.7
Auburn Formation:		
Shale, greenish gray	145.7	146.6
Shale, gray	146.6	147.6
Shale, reddish gray	147.6	148.2
Shale, greenish gray	148.2	148.4
Shale, red and green, interbedded	148.4	149.5
Shale, dark red	149.5	152.0
Shale, greenish gray with interbedded green limestone seams	152.0	153.5
Shale, dark reddish brown	153.5	161.8
Shale, light yellowish brown	161.8	164.2
Shale, gray, clayey	164.2	178.1
Wakarusa Formation:		
Limestone, gray, finely crystalline, shaly in upper 1.0 ft., contains crinoids	178.1	180.0
Limestone, medium gray with dark gray inclusions	180.0	180.9
Soldier Creek Formation:		
Shale, dark gray with thin dark gray limestone seams	180.9	185.0

Burlingame Formation:		
South Fork Member:		
Limestone, greenish gray.....	185.0	187.4
Shale, dark gray.....	187.4	187.9
Limestone, brown.....	187.9	189.5
Winnebago Member:		
Shale, dark red.....	189.5	190.0

Test Hole #20-A-61
Otoe county

Location: NW corner NW sec. 18, T. 7 N., R. 12 E., approximately 4 feet south of north section line and 98 feet east of west section line.
Ground elevation: 1,001.0 ft. (Talmage 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Topsoil, very silty, slightly clayey, dark gray.....	0.0	0.5
Silt, moderately clayey, dark grayish brown.....	0.5	1.4
Silt, moderately clayey, dark gray, below 5.7 ft. very clayey.....	1.4	10.0
Silt, very clayey, grayish brown, rare limy nodules.	10.0	13.7
Clay, gray, below 17.0 ft. some reworked shale fragments.....	13.7	19.8
Clay, dark gray, from 20.0 to 23.8 ft. trace of very fine sand, below 23.8 ft. very sandy.....	19.8	28.0
Sand, gravelly, fine sand to medium gravel.....	28.0	30.0
Gravel, sandy, fine sand to medium gravel, few pebbles, some reworked material.....	30.0	40.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wakarusa Formation:		
Limestone, pale yellow, finely crystalline, contains abundant crinoids and brachiopods.....	40.0	41.8
Soldier Creek Formation:		
Shale, pale yellow.....	41.8	44.6
Burlingame Formation:		
South Fork Member:		
Limestone, light brown, irregularly crystalline.....	44.6	46.7
Limestone, light brown, irregularly crystalline, glauconite (iron stain).....	46.7	48.0
Shale, pale yellow.....	48.0	48.2
Limestone, light brown, irregularly crystalline, (iron stain).....	48.2	49.0
Shale, pale yellow.....	49.0	49.4
Limestone, light brown, finely crystalline.....	49.4	50.9
Winnebago Member:		
Shale, dark reddish brown.....	50.9	54.7
Shale, as above and light greenish gray.....	54.7	54.8
Shale, medium olive.....	54.8	55.0
Shale, medium to dark gray.....	55.0	65.7
Taylor Branch Member:		
Limestone, dark gray, finely crystalline, contains brachiopod fragments and spines.....	65.7	66.7
Limestone, light gray, very finely crystalline.....	66.7	67.5
Shale, light greenish gray.....	67.5	68.2
Limestone, light brown, finely crystalline, "granular looking".....	68.2	70.6
Scranton Formation:		
Shale, light greenish gray.....	70.6	71.0
Shale, medium gray, very finely micaceous, very		

fine grained, shaly.....	71.0	75.0
Shale, light gray, very fine sandstone seams.....	75.0	80.7

Test Hole #34-B-67
Otoe County

Location: SE SE SW SE sec. 26, T. 7 N., R. 12 E., approximately 10 feet north of south section line and 1,435 feet west of east section line.
Ground elevation: 995.0 ft. (Talmage 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	2.5
Silt, clayey, olive brown, some limestone fragments.	2.5	5.0
Silt, clayey, light yellowish brown, below 5.0 ft. sandy, brown	5.0	10.5
Clay, silty, slightly calcareous, light gray	10.5	11.5
Silt, clayey, light yellowish brown, below 13.0 ft. sandy	11.5	18.0
Sand, silty, sand is very fine to fine, trace of pebbles	18.0	20.5
Gravel, very fine to coarse	20.5	21.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, pale olive, silty	21.0	23.0
Shale, reddish brown, clayey	23.0	23.8
Shale, reddish gray mottled with light greenish gray	23.8	25.0
Siltstone, light gray stained with red	25.0	25.5
Limestone, yellowish brown, soft, contains manganese dendrites	25.5	25.7
Shale, reddish brown mottled with light greenish gray	25.7	28.5
Shale, pale reddish gray with some interbedded light gray siltstone	28.5	31.0
Shale, very light gray, clayey	31.0	32.0
Shale, dark gray, clayey	32.0	33.0
Emporia Formation:		
Elmont Member:		
Limestone, light to medium gray, very finely crystalline, contains crinoids and brachiopods	33.0	33.7
Shale, yellowish brown mottled with light gray	33.7	34.5
Limestone, light tannish gray, very finely crystalline, contains brachiopod spines	34.5	34.6
No sample - loss of circulation	34.6	36.5

Test Hole #4-B-39
(A7-12-28dc)
Otoe County

Location: SW SE sec. 28, T. 7 N., R. 12 E., approximately 650 feet north and 2,300 feet west of southeast corner.
Ground elevation: 1,005.0 ft. (Talmage 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Silt, pale yellow.....	0.0	7.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, bluish and black, carbonaceous.....	7.0	10.0
Wakarusa Formation:		
Limestone, russet, contains Rhombopora, crinoids, Ambocoelia, Derbya, spriiferina kentuckyensis, some bluish limestone.....	10.0	11.3
Shale, russet.....	11.3	12.8
Limestone, bluish gray, hard, dense, contains Rhombopora lepodendroides, Ambocoelia, derbya, crinoid stems.....	12.8	13.3
Shale, blue.....	13.3	18.5
Shale, harder drilling, probably calcareous, drills easier than limestone but harder than shale, consolidated (mudstone?) 2" shale break 6" below top. 10" below top drills like limestone. Yellow with black spots.....	18.5	20.1
White "limy-like" material.....	20.1	20.8
Winnebago Member:		
Shale, red, upper 2" to 3" bluish green.....	20.8	33.8
Taylor Branch Member:		
Limestone, hard, dense, light bluish gray.....	33.8	35.3
Shale.....	35.3	36.6
Limestone, light blue when wet, light gray when dry.	36.6	40.1
Scranton Formation:		
Shale, light bluish green.....	40.1	42.5
Shale, darker, sub-fissile.....	42.5	45.0
Shale, same as above, black.....	45.0	49.8
Shale, black fissile.....	49.8	50.1
Shale, black, sub-fissile, 3" zone at 53.0 ft., tough, fissile.....	50.1	53.5
Shale, bluish gray, might be banded with black shale	53.5	55.7
Shale, green, somewhat calcareous.....	55.7	58.3
Shale, red.....	58.3	62.8
Harder drilling a little lime, and green and red shale.....	62.8	63.0
Shale, red.....	63.0	68.5
Shale, red, blue, black, banded.....	68.5	71.5
Shale, black.....	71.5	80.0
Shale, bluish black, sub-fissile.....	80.0	93.1

Limestone, hard drilling.....	93.1	93.5
Shale, blackish, sub-fissile.....	93.5	130.0
Howard Formation:		
Limestone, fossiliferous, dark gray, very dense and very hard, contains Ambocoelia, crinoids, fusulinids, molluscs, Rhombopora, marcasite, plentiful, 1" shale break at 132.3 ft.....	130.0	134.2

Test Hole #3-A-66
Otoe County

Location: SW SE sec. 1, T. 7 N., R. 13 E., approximately 9 feet north of south section line and 2,309 feet west of east section line.
Ground elevation: 1,175.5 ft. (Paul 7.5 min. quadrangle)
Depth to water: 20.4 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
No sample	0.0	1.0
Silt, very clayey, brown, some iron stain	1.0	1.5
Silt, slightly clayey, slightly sandy, light yellowish brown, in places brownish gray and brown, some iron stain, below 15.0 ft. some pebbles	1.5	16.2
Till: clay, silty, sandy, slightly calcareous, brown, some yellowish brown, some gravel grains, below 25.0 ft. some limestone fragments	16.2	30.0
Till: clay, silty, sandy, gravelly, moderately calcareous, yellowish brown, some pale yellow and brownish gray	30.0	41.6
Sand, very fine sand to fine gravel, much quartz, brownish gray	41.6	43.0
Till: clay, sandy, gravelly, slightly calcareous, below 51.5 ft. moderately calcareous, yellowish brown, some grayish brown and brownish gray	43.0	55.0
Till: clay, silty, sandy, gravelly, slightly calcareous, brownish gray, below 55.7 ft. olive brown	55.0	56.9
Sand, very fine to coarse	56.9	57.9
Till: clay, silty, sandy, gravelly, moderately calcareous, brownish gray, below 60.9 ft. yellowish brown, below 62.7 ft. slightly calcareous	57.9	63.7
Silt, clayey, sandy, light brownish gray	63.7	65.4
Sand, very fine to coarse	65.4	70.0
Sand, very fine to medium, below 140.0 ft. some coarse	70.0	145.0
Sand, fine to coarse, below 150.0 ft. some silt lenses	145.0	162.5
Silt, moderately clayey, sandy, pale olive, sand is very fine, below 166.5 ft. gray to grayish brown	162.5	176.6
Silt, moderately clayey, sandy, moderately calcareous, light brownish gray, sand is very fine, below 181.1 ft. light yellowish brown	176.6	182.3
Sand, gravelly, fine sand to medium gravel, some silt seams	182.3	186.8
Silt, clayey, sandy, slightly calcareous, yellowish brown, sand is fine to medium, some coarse, below 190.0 ft. brown	186.8	193.8
Silt, clayey, sandy, slightly calcareous, gray, sand is fine to medium	193.8	195.1
Silt, clayey, sandy, grayish brown, sand is very fine, below 198.5 ft. slightly calcareous	195.1	200.6

Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Stotler Formation:		
Dry Member:		
Sandstone, yellowish brown, lime cemented, very fine grained	200.6	200.9
Shale, pale olive and medium yellow, very finely micaceous, sandy	200.9	203.0
Shale, light gray, very finely micaceous, non-calcareous, sandy	203.0	215.0
Shale, light gray, clayey, non-calcareous	215.0	228.3
Dover Member:		
Limestone, dark gray, very finely crystalline, very shaly, contains pyrite	228.3	228.5
Pillsbury Formation:		
Shale, light greenish gray, sandy	228.5	229.7
Sandstone, light greenish gray, fine- to very fine-grained, micaceous, shaly, soft	229.7	232.4
Sandstone, light greenish gray, very fine- to fine-grained, hard	232.4	234.8

Test Hole #5-B-66
Otoe county

Location: SE NE SE sec. 24, T. 7 N., R. 13 E., approximately 1,710 feet north of south section line and 5 feet west of east section line.
Ground elevation: 1,138.0 ft. (Paul 7.5 min. quadrangle)
Depth to water: 28.0 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Clay, silty, dark grayish brown.....	0.0	1.0
Silt, moderately clayey, slightly sandy, brown, sand is very fine to fine.....	1.0	3.0
Silt, moderately clayey, yellowish brown, below 5.0 ft. pale brown.....	3.0	10.5
Clay, slightly silty, light brownish gray.....	10.5	13.0
Silt, moderately clayey, sandy, grayish brown, sand is very fine to fine, below 14.0 ft. sand is very fine to medium.....	13.0	15.5
Silt, very clayey, sandy, yellowish brown, sand is very fine to medium, below 15.5 ft. brown.....	15.5	16.0
Clay, silty, sandy, grayish brown, sand is very fine to medium, below 17.0 ft., brown.....	16.0	19.5
Till: clay, silty, sandy, gravelly, pale brown, below 24.0 ft. slightly calcareous.....	19.5	25.0
Till: clay, silty, sandy, gravelly, moderately calcareous, yellowish brown, below 26.1 ft. grayish brown, some shale fragments.....	25.0	26.6
Till: clay, silty, sandy, gravelly, slightly calcareous, yellowish brown, some shale fragments, from 27.1 to 30.5 ft. pale brown, below 30.5 ft. light brownish gray to olive brown.....	26.6	35.0
Till: clay, silty, sandy, gravelly, slightly calcareous, yellowish brown, some pale brown, below 43.2 ft. moderately calcareous.....	35.0	45.0
Till: clay, silty, sandy, gravelly, slightly calcareous, in places moderately calcareous, light yellowish brown, some pale brown and grayish brown, some iron and manganese stain.....	45.0	70.0
Sand, silty, slightly clayey, sand is very fine to medium.....	70.0	76.0
Silt, very sandy, slightly clayey, brown, sand is very fine to medium.....	76.0	79.0
Silt, very clayey, sandy, brown, sand is very fine to medium.....	79.0	81.0
Sand, silty, sand is very fine to coarse, below 90.0 ft. sand is very fine to fine with some medium, limy grains.....	81.0	95.0
Sand, very fine to medium, from 125.0 to 130.0 ft. less medium.....	95.0	143.0

Silt, very sandy, slightly clayey, slightly calcareous, brown, sand is very fine to fine.....	143.0	143.5
Sand, very fine to medium.....	143.5	146.5
Clay, silty, sandy, slightly calcareous, brown, sand is very fine to fine.....	146.5	147.0
Sand, very fine to medium, limy grains, from 150.0 to 160.0 ft. interbedded silt lenses.....	147.0	164.8
Silt, very sandy, slightly clayey, in part moderately calcareous, dark gray, sand is very fine to fine, in places interbedded silty sand lenses, below 170.0 ft. slightly calcareous.....	164.8	210.0
Sand, very fine to fine, some medium, below 215.0 ft. some coarse.....	210.0	220.0
Sand, gravelly, fine sand to fine gravel, below 225.0 ft. some medium gravel with a trace of coarse gravel.....	220.0	232.2
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Pillsbury Formation:		
Shale, light bluish gray, silty, very slightly calcareous.....	232.2	237.5
Willard - Zeandale Formations:		
Maple Hill Member:		
Limestone, medium bluish gray, finely crystalline, shaly, contains crinoids and pyrite.....	237.5	238.3
Coal, black.....	238.3	238.4
Shale, light greenish gray, sandy, very finely micaceous, contains some thin sandstone seams.....	238.4	247.8
Sandstone, medium gray, very fine- to fine grained, hard, micaceous, moderate to very calcareous.....	247.8	248.7
Shale, light gray, sandy, very finely micaceous with thin interbedded sandstone seams.....	248.7	249.0
Sandstone, light gray, very fine-grained, very finely micaceous with black carbonaceous streaks..	249.0	255.7
Shale, light gray, sandy.....	255.7	257.5
Shale, light gray, clayey.....	257.5	269.5
Limestone, dark gray, finely crystalline with interbedded medium gray shale, contains brachiopods....	269.5	270.0
Shale, light gray with thin interbedded limestone seams.....	270.0	271.5
Shale, medium gray, silty, moderately calcareous....	271.5	277.8
Shale, medium gray, contains thin interbedded limestone seams.....	277.8	278.0
Shale, light greenish gray with lime nodules.....	278.0	278.9
Shale, medium reddish brown mottled with light greenish gray, moderately calcareous.....	278.9	280.5

Test Hole #4-B-35
(A8-9-6cc)
Otoe County

Location: SW NW SW sec. 6, T. 8 N., R. 9 E., approximately 1,800 feet north and 60 feet east of southwest corner.
Ground elevation: 1,204.0 ft. (Palmyra 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil	0.0	2.0
Silt, in part clayey	2.0	9.0
Sand, boulder at 10.0 ft	9.0	10.0
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Hughes Creek Member:		
Shale, reworked	10.0	13.0
Limestone	13.0	13.7
Shale	13.7	15.3
Limestone	15.3	16.0
Shale, bluish gray	16.0	19.4
Americus Member:		
Limestone	19.4	20.1
Shale	20.1	23.0
Limestone	23.0	23.4
Hamlin Formation:		
Oaks Member:		
Shale, varigated	23.4	36.7
Houchens Creek Member:		
Limestone, light gray, finely crystalline	36.7	38.2
Stine Member:		
Shale, gray	38.2	42.5
Limestone, bluish gray	42.5	44.2
Shale, light bluish gray	44.2	45.0
Limestone, bluish gray	45.0	45.5
Shale, varigated	45.5	52.0
Five Point Formation:		
Limestone, with limy shale from 54.0 to 56.5 ft. and 52.0 to 54.0 limestone, light gray finely crystalline, contains Osagia	52.0	58.3
West Branch Formation:		
Shale, red grading to gray	58.3	61.7
Limestone, light gray to light greenish gray, finely crystalline	61.7	63.9
Shale, bluish gray	63.9	69.9
Falls City Formation:		
Limestone	69.9	70.6
Shale, limy	70.6	73.5
Limestone, gray, contains shale layers from 74.0 to 74.4 ft. and 77.0 to 77.6 ft	73.5	77.9

Onaga Formation:		
Shale, grayish green	77.9	85.1
Shale, limy, red with some green and white	85.1	87.1
Shale, dark red	87.1	95.9
Limestone, gray	95.9	96.3
Shale, bluish gray	96.3	97.9
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, gray	97.9	99.7
Pony Creek - Plumb Members:		
Shale	99.7	102.0
Coal	102.0	102.5
Shale, red, contains hard layers at 114.5 ft. and from 118.5 to 121.0 ft	102.5	123.5
Nebraska City Member:		
Limestone, light gray, finely crystalline, and reddish brown, irregular crystalline, contains fusulinids	123.5	125.6
Root Formation:		
shale, dark gray, possibly contains a thin coal layer at 127.0 ft	125.6	130.4
Limestone	130.4	130.9
Shale, light bluish gray	130.9	146.3
Shale, sandy, limy	146.3	148.3
Stotler Formation:		
Grandhaven Member:		
Limestone, sandy, dark bluish gray	148.3	152.3
Dry Member:		
Shale, sandy in upper part, grayish blue, dark gray below 185.0 ft., contains coal layer in interval from 183.0 to 185.0 ft	152.3	195.4
Dover Member:		
Limestone, light gray	195.4	196.7
Pillsbury Formation:		
Shale, limy	196.7	198.7
Limestone	198.7	199.0

Test Hole #4-A-61
Otoe county

Location: NE corner sec. 13, T. 8 N., R. 9 E., approximately 176 feet south of north section line and 13.5 feet west of east section line.
Ground elevation: 1,249.7 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: 12.81 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated: Top soil, moderately clayey, dark brown.....	0.0	0.5
Silt, moderately clayey, dark brownish gray, below 1.0 ft. dark brown.....	0.5	2.0
Silt, very clayey, yellowish brown, below 3.0 ft. some dark staining.....	2.0	4.0
Silt, slightly clayey, yellowish brown, below 8.5 ft. very sandy, moderately clayey, dark yellowish brown, sand is very fine.....	4.0	9.5
Silt, very clayey, slightly sandy to gravelly, dark yellowish brown.....	9.5	10.0
Till: clay, sandy to gravelly, brownish gray, below 11.9 ft. less and and gravel, pale yellow to yellowish brown, below 13.9 ft. moderately calcareous, some limy nodules.....	10.0	44.0
Sand, very silty, clayey, very fine to very coarse with a trace of gravel.....	44.0	45.5
Till: clay, silty, sandy to gravelly, moderately calcareous, brown, from 46.5 to 53.2 ft. olive brown, below 53.2 ft. olive gray to olive brown...	45.5	58.0
Sand, moderately silty, very fine to medium, some coarse grains.....	58.0	65.5
Till: clay, silty, sandy, very calcareous, gray to olive brown.....	65.5	70.3
Sand, slightly silty, very fine to fine, some medium, from 76.2 to 76.3 ft. interbedded silt lens, below 80.0 ft. very fine to coarse, with a trace of fine gravel.....	70.3	86.5
Silt, slightly clayey, moderately calcareous, dark olive gray.....	86.5	93.1
Clay, silty, moderately calcareous, dark gray.....	93.1	95.0
Till: clay, silty, sandy, moderately calcareous, dark gray, trace of limy grains from 100.0 to 105.0 ft., below 105.0 ft. sandy to slightly gravelly.....	95.0	111.6
Sand, very fine to medium, some coarse, trace of fine gravel.....	111.6	113.5
Till: clay, silty, sandy to gravelly, slightly calcareous.....	113.5	125.4
Sand, very fine to medium.....	125.4	130.3
Till: clay, silty, sandy to gravelly, moderately calcareous, dark gray, below 145.0 ft. some limy nodules.....	130.3	165.0

Till: clay, silty, sandy, slightly calcareous, trace of shell fragments to 170.0 ft.....	165.0	185.0
Clay, silty, moderately calcareous, gray, below 190.0 ft. some limy grains.....	185.0	195.0
Silt, moderately clayey, very calcareous, gray, some limy grains.....	195.0	197.4
Clay, silty, moderately calcareous, gray, some limy grains.....	197.4	199.0
Silt, very clayey, slight to in part very calcareous, dark gray.....	199.0	205.0
Clay, silty, slightly calcareous, light gray.....	205.0	210.0
Silt, moderately clayey, very sandy, dark gray, sand is very fine to medium.....	210.0	212.1
Clay, silty, light gray, trace of very fine to medium sand.....	212.1	217.6
Sand, very fine to medium, some limy grains, from 220.0 to 225.0 ft. very fine to coarse, some very coarse sand and a trace of fine gravel.....	217.6	226.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Burlingame Formation:		
South Fork Member:		
Limestone, brown, finely crystalline, contains bryozoans, brachiopods, fusulinids and crinoids...	226.5	229.0
Winnebago Member:		
Shale, medium to dark gray.....	232.0	233.9
Limestone, light gray, finely crystalline, contains fossil fragments.....	233.9	234.0
Shale, medium to dark gray.....	234.0	239.0
Taylor Branch Member:		
Limestone, light gray, finely crystalline, contains fusulinids.....	239.0	240.0
Limestone, light gray, finely crystalline, glauconitic with calcite string, contains bryozoans.....	240.0	241.6
Limestone, light gray, finely crystalline with light greenish gray shale interbedded.....	241.6	242.0
Limestone, light greenish gray, soft, shaly.....	242.0	243.0
Scranton Formation:		
Shale, dark reddish brown.....	243.0	252.2
Limestone, white, very finely crystalline, stained red.....	252.2	253.0
Shale, dark reddish brown.....	253.0	258.0
Shale, light greenish gray and dark reddish brown interbedded.....	258.0	258.5
Shale, light greenish gray mottled with pale yellow.	258.5	259.0
Shale, light gray, very finely micaceous, sandy.....	259.0	270.0
Shale, light gray, very finely micaceous, slightly sandy.....	270.0	280.0

Test Hole #4-B-73
Otoe County

Location: NE NE SE SE sec. 13, T. 8 N., R. 9 E., approximately 1,046 feet north of south section line and 8 feet west of east section line.
Ground elevation: 1,247.2 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: 12.5 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Soil: silt, clayey, dark brown to black	0.5	3.2
Clay, silty, sandy, brown, sand is very fine to fine	3.2	6.1
Clay, silty, sandy, brownish yellow to yellow, sand is very fine to coarse, from 10.0 to 17.5 ft. some fine gravel, below 17.5 ft. some coarse gravel	6.1	18.7
Clay, silty, sandy, brownish yellow to yellow, sand if fine to coarse, below 20.0 ft. slightly calcareous, some iron stain, below 25.8 ft. in places some brown	18.7	29.1
Clay, silty, sandy, slightly calcareous, light brownish yellow, sand is very fine to medium	29.1	35.0
Sand and gravel, very fine sand to fine gravel	35.0	36.8
Sand, silty, sand is very fine to fine, below 37.0 ft. iron stain	36.8	48.0
Silt, clayey, sandy, slightly calcareous, brownish yellow to 55.0 ft., below 55.0 ft. olive to grayish brown, sand is very fine to fine	48.0	63.7
Clay, silty, sandy, slightly calcareous, dark gray, sand is very fine to medium	63.7	83.5
Boulder, granite	83.5	84.4
Clay, silty, sandy, slightly calcareous, dark greenish gray, below 100.0 ft. dark gray	84.4	120.0
Clay, silty, sandy, slightly calcareous, gray, sand is very fine to coarse with a trace of gravel	120.0	126.4
Clay, silty, gray, below 128.5 ft. sandy, sand is very fine	126.4	130.0
Silt, moderately clayey, sandy, slightly calcareous, gray, sand is very fine, below 134.8 ft. some limestone fragments	130.0	136.4
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, greenish gray with limestone fragments	136.4	137.0
Shale, weak red	137.0	137.8
Shale, weak red with greenish gray mottling	137.8	138.3
Shale, light greenish gray	138.3	139.0
Emporia Formation:		
Elmont - Reading Members:		
Limestone, brownish gray, very finely crystalline, contains abundant crinoids	139.0	140.4
Shale, pale yellowish gray	140.4	141.8
Limestone, yellowish brown, finely crystalline	141.8	144.0

Shale, pale yellowish gray	144.0	144.6
Limestone, yellowish brown, very finely crystalline, contains crinoids	144.6	145.3
Limestone, pale yellowish brown with interbedded shale	145.3	147.8
Auburn Formation:		
Shale, greenish gray	147.8	149.0
Shale, dark reddish brown	149.0	155.7
Shale, dark reddish brown with greenish gray mottling and very thin interbedded finely micaceous dark gray sandstone lenses	155.7	159.4
Shale, olive gray with interbedded micaceous siltstone or sandstone lenses	159.4	161.0
Shale, gray with interbedded siltstone or sandstone lenses	161.0	163.4
Shale, medium to dark gray, clayey	163.4	172.3
Shale, light gray	172.3	173.0
Wakarusa Formation:		
Limestone, medium gray, very finely crystalline, contains crinoids, brachiopods, fusulinids and interbedded light gray shale	173.0	177.2
Soldier Creek Formation:		
Shale, light greenish gray, clayey	177.2	179.2
Burlingame Formation:		
South Fork Member:		
Limestone, brownish gray, very finely crystalline with few interbedded light greenish gray shale seams	179.2	180.5
Winnebago Member:		
Shale, grayish brown with interbedded limestone seams	180.5	181.0
Shale, reddish brown	181.0	182.3
Shale, light to medium gray	182.3	183.4
Limestone, light gray	183.4	184.0
Shale, medium gray	184.0	184.5
Limestone, grayish brown	184.5	185.3
Shale, light greenish gray	185.3	186.5
Shale, medium gray	186.5	194.0
Taylor Branch Member:		
Limestone, medium gray	194.0	195.3
Shale, medium gray, pyritized clams	195.3	196.2
Limestone, medium gray	196.2	196.8
Shale, greenish gray	196.8	197.0
Limestone, greenish gray	197.0	197.5
Scranton Formation:		
Shale, greenish gray	197.5	198.5
Shale, dark reddish brown	198.5	204.0
Shale, dark reddish brown, sandy	204.0	207.0
Shale, red with interbedded greenish gray	207.0	209.0
Shale, red	209.0	210.4
Shale, greenish gray	210.4	212.0
Shale, light gray, sandy	212.0	217.5
Shale, light gray with some interbedded limestone lenses	217.5	222.0

Shale, gray, sandy	222.0	225.0
Shale, gray, clayey	225.0	239.9
Shale, gray, contains pyrite and black carbonaceous streaks	239.9	240.2
Shale, light to medium gray	240.2	245.0
Shale, light to medium gray, contains pyrite	245.0	250.0
Shale, gray, sandy	250.0	268.2
Shale, gray, sandy with some sandstone seams	268.2	273.0
Howard Formation:		
Limestone, medium to dark gray, very finely crystalline, contains brachiopods, crinoids, fusulinids with interbedded gray shale	273.0	275.0
Limestone, tannish gray, very finely to finely crystalline, contains crinoids	275.0	278.3
Severy Formation:		
Shale, gray, sandy	278.3	278.7
Shale, black	278.7	279.3
Shale, gray, sandy	279.3	280.0
Shale, gray	280.0	289.6
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, light to medium gray, very finely crystalline, contains ostracods and brachiopods	289.6	292.6
Shale, gray	292.6	293.3
Limestone, light to medium gray, finely crystalline, contains brachiopods and crinoids	293.3	294.9
Shale, dark gray	294.9	295.7
Limestone, light gray, very finely crystalline, contains crinoids and brachiopods	295.7	298.1
Holt Member:		
Shale, dark gray and black carbonaceous	298.1	299.9
Shale, medium gray	299.9	300.0

Test Hole #3-A-61
Otoe County

Location: SE SE NE sec. 25, T. 8 N., R. 9 E., approximately 2,601 feet south of north section line and 645 feet west of east section line.
Ground elevation: 1,304.8 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: 4.66 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Top Soil: silt, slightly clayey, slightly calcareous, very dark gray	0.0	0.5
Silt, moderately clayey, dark gray	0.5	1.5
Silt, moderately clayey, yellowish brown with some brown, below 6.2 ft. very clayey	1.5	8.5
Clay, silty, pale brown, some iron stain	8.5	9.1
Till: clay, silty, in part sandy to gravelly, light yellowish brown, some pale brown, some limy grains	9.1	10.0
Till: clay, silty, sandy to gravelly, slightly calcareous, pale brown, some iron staining	10.0	40.0
Till: clay, silty, sandy to gravelly, slightly calcareous, light olive gray, some iron staining, below 57.0 ft. light brownish gray to yellowish brown	40.0	75.0
Till: clay, silty, sandy to gravelly, slightly calcareous, dark gray, some limy grains	75.0	126.4
Sand, slightly silty, very fine to medium sand, below 145.0 ft. some coarse sand to fine gravel	126.4	161.1
Limestone, boulder	161.1	162.0
Sand and gravel, very fine sand to fine gravel, some medium gravel	162.0	171.7
Permian System - Big Blue Series - Council Grove Group:		
Johnson Formation:		
Shale, pale olive, moderately calcareous	171.7	173.5
Shale, medium gray, slightly calcareous	173.5	175.5
Shale, maroon and light greenish gray	175.5	176.1
Shale, dark reddish brown	176.1	177.0
Shale, light greenish gray and maroon	177.0	177.8
Foraker Formation:		
Long Creek Member:		
Limestone, pale yellow, fine grained, soft	177.8	179.8
Shale, medium greenish gray, slightly calcareous	179.8	180.9
Limestone, light gray, fine grained to very finely crystalline with some interbedded shale	180.9	184.8
Hughes Creek Member:		
Shale, light greenish gray, slightly calcareous	184.8	186.0
Shale, medium gray, moderately calcareous	186.0	192.9
Limestone, medium bluish gray, finely crystalline, contains fusulinids, fossil fragments and "algal looking material", brachiopods	192.9	195.0

Shale, medium gray, moderately calcareous.....	195.0	209.8
Limestone, medium bluish gray, finely crystalline, contains brachiopods and fossil fragments.....	209.8	210.7
Shale, dark gray to black.....	210.7	211.4
Shale, medium gray.....	211.4	211.8
Limestone, medium to dark gray, very finely crystalline, contains brachiopods and fusulinids.....	211.8	214.0
Shale, medium bluish gray, slightly calcareous.....	214.0	215.0
Limestone, light gray, very finely crystalline, contains fossil fragments and spines, "algal looking material", and crinoids.....	215.0	219.5
Shale, light greenish gray and some medium gray.....	219.5	220.5

Test Hole #6-81
Otoe County

Location: SW corner sec. 1, T. 8 N., R. 10 E., approximately 207 feet north of south section line and 103 feet east of west section line.
Ground elevation: 1,133.5 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	4.5
Clay, gray to tan, sandy	4.5	10.0
Clay, gray, silty, sandy	10.0	19.0
Clay, gray to brown, silty, sandy	19.0	25.0
Clay, gray, sandy	25.0	32.0
Clay, brown to gray, sandy	32.0	38.5
Clay, gray, sandy	38.5	47.0
Clay, gray, very silty, sandy	47.0	105.5
Clay, dark gray, very silty, sandy	105.5	108.9
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Burlingame Formation:		
Shale, gray to dark gray	108.9	109.3
Shale, olive	109.3	110.2
Shale, olive, interbedded with limestone, gray	110.2	111.4
Shale, medium gray	111.4	112.1
Limestone, gray to tan, variably crystalline, contains glauconite, interbedded with shale, olive	112.1	113.0
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, light green	113.0	114.8
Shale, black	114.8	115.4
Shale, medium greenish gray	115.4	123.5
Shale, red mottled green	123.5	134.2
Shale, light gray	134.2	139.5
Coal, black	139.5	139.9
Shale, light gray	139.9	167.0
Shale, medium gray	167.0	188.3
Howard Formation:		
Limestone, light gray, finely crystalline, contains brachiopods, interbedded with shale, medium gray	188.3	190.4
Limestone, medium gray, very finely crystalline, interbedded with shale, medium gray	190.4	190.7
Shale, medium gray	190.7	193.4
Limestone, medium gray, very finely crystalline, contains fusulinids, Osagia, and "black inclusions"	193.4	194.7
Limestone, light gray to tan, very finely crystalline, contains fusulinids, Osagia, and coarsely crystalline calcite streaks	194.7	198.6
Severy Formation:		
Coal, black	198.6	199.4
Siltstone, light gray	199.4	205.0

Test Hole #5-81
Otoe County

Location: SE corner sec. 4, T. 8 N., R. 10 E., approximately 94 feet north of south section line and 15 feet west of east section line.
Ground elevation: 1,159.5 ft. (Unadilla 7.5 min. quadrangle)
Depth to water:

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, brown, silty, sandy	3.0	6.5
Clay, light brown, silty, sandy	6.5	11.0
Clay, medium gray to brown, silty, sandy	11.0	14.5
Clay, brown, sandy	14.5	17.0
Clay, brown, very sandy	17.0	24.5
Clay, medium gray to brown, sandy	24.5	38.0
Clay, medium gray, slightly sandy	38.0	43.4
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Emporia Formation:		
Reading Member:		
Limestone, light gray, finely crystalline	43.4	44.9
Shale, medium gray	44.9	46.2
Limestone, tan, weathered, finely crystalline, contains fusulinids, crinoids, Osagia and manganese staining	46.2	48.1
Auburn Formation:		
Shale, olive	48.1	50.1
Shale, red	50.1	58.0
Shale, red mottled green	58.0	59.0
Shale, red	59.0	63.7
Shale, red, interbedded with limestone, medium gray	63.7	66.5
Shale, green mottled red	66.5	70.8
Shale, medium gray	70.8	79.3
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, interbedded with shale, medium gray	79.3	80.3
Limestone, medium gray, finely crystalline, contains fusulinids and brachiopods	80.3	83.2
Limestone, light to medium gray, finely crystalline, contains fusulinids	83.2	84.0
Soldier Creek Formation:		
Shale, medium gray mottled red	84.0	85.3
Limestone, medium gray, very finely crystalline	85.3	86.2
Shale, medium reddish gray	86.2	87.2
Shale, medium gray	87.2	88.6
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, finely crystalline, contains Osagia	88.6	89.6
Limestone, light gray, very finely crystalline, contains glauconite	89.6	91.8

Winnebago Member:		
Shale, medium gray.....	91.8	101.2
Taylor Branch Member:		
Limestone, medium gray, finely crystalline, contains "black inclusions".....	101.2	103.1
Shale, medium greenish gray.....	103.1	104.2
Limestone, light gray, very finely crystalline, interbedded with shale, red.....	104.2	106.5
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, red.....	106.5	107.0
Shale, red mottled gray.....	107.0	109.2
Shale, green.....	109.2	110.2
Shale, red.....	110.2	117.2
Shale, red, interbedded with limestone, medium gray.	117.2	120.1
Shale, light gray.....	120.1	122.3
Shale, medium gray.....	122.3	123.1
Limestone, medium gray, very finely crystalline, contains Osagia, interbedded with shale, dark gray.....	123.1	123.3
Shale, light gray.....	123.3	129.8
Coal, black.....	129.8	130.2
Shale, medium gray.....	130.2	136.0

Test Hole #4-81
Otoe County

Location: SE corner NE NE SE sec. 5, T. 8 N., R. 10 E., approximately 2,012 feet north of south section line and 30 feet west of east section line.
Ground elevation: 1,149.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, brown, silty	3.0	6.5
Clay, light tan, very silty	6.5	20.0
Clay, light tan, sandy	20.0	38.5
Clay, tan, silty	38.5	43.0
Clay, gray, sandy, silty	43.0	47.0
Clay, medium gray, sandy	47.0	51.0
Clay, light gray, sandy	51.0	62.0
Clay, medium gray, sandy	62.0	69.0
Clay, medium gray, contains gravel	69.0	74.5
Pennsylvanian Series - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, olive	74.5	76.8
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, interbedded with shale, medium gray	76.8	79.6
Shale, black, contains carbonaceous material	79.6	80.0
Limestone, medium gray, finely to very finely crystalline, contains brachiopods and pyrite	80.0	80.4
Soldier Creek Formation:		
Shale, medium gray	80.4	82.0
Shale, reddish gray	82.0	84.2
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, very finely crystalline	84.2	86.1
Winnebago Member:		
Shale, gray to tan	86.1	87.8
Shale, medium gray	87.8	92.0
Shale, dark gray	92.0	98.3
Taylor Branch Member:		
Limestone, medium gray, finely crystalline, contains gastropods and pyrite	98.3	100.4
Limestone, medium gray, variably crystalline, contains Osagia	100.4	101.4
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, medium greenish gray	101.4	102.6
Shale, medium olive gray	102.6	104.3
Shale, grayish red	104.3	105.0
Shale, light green	105.0	108.0
Shale, dark red	108.0	111.5
Shale, red	111.5	115.0

Shale, red, interbedded with limestone, gray.....	115.0	115.5
Shale, dark red.....	115.5	118.0
Shale, olive.....	118.0	118.8
Shale, medium gray.....	118.8	126.7
Shale, light gray.....	126.7	128.0
Coal, black.....	128.0	128.4
Shale, light gray.....	128.4	130.0
Shale, medium gray.....	130.0	137.0

Test Hole #19-81
Otoe County

Location: SW corner sec. 11, T. 8 N., R. 10 E., approximately 23 feet north of south section line and 103 feet east of west section line.
Ground elevation: 1,143.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	4.0
Silt, brown, sandy	4.0	9.0
Clay, brown, very sandy	9.0	14.0
Clay, brown, sandy	14.0	22.0
Clay, light brown, sandy	22.0	28.5
Clay, medium gray	28.5	29.0
Clay, dark gray	29.0	35.0
Clay, black	35.0	38.0
Clay, dark gray	38.0	39.0
Clay, medium gray	39.0	41.5
Clay, tan	41.5	48.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, olive	48.0	50.0
Limestone, medium gray, finely crystalline, pseudo-oolitic, contains brachiopods, crinoids, and Osagia	50.0	50.6
Shale, light gray	50.6	55.0
Shale, red	55.0	55.7
Shale, medium gray	55.7	56.5
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light grayish green, very finely crystalline, pseudo-oolitic in part, contains crinoids, and Osagia	56.5	57.1
Shale, medium gray, interbedded with limestone, gray	57.1	59.0
Shale, medium gray	59.0	59.6
Limestone, light gray, very finely crystalline, contains Osagia	59.6	61.2
Shale, medium gray	61.2	62.2
Limestone, light gray, very finely crystalline, contains Osagia	62.2	65.5
Auburn Formation:		
Shale, medium greenish gray	65.5	67.0
Shale, red	67.0	80.0
Shale, olive	80.0	82.0
Shale, light gray	82.0	84.5
Shale, medium gray	84.5	92.0
Shale, medium gray, contains thin sandstone streaks.	92.0	94.5
Wakarusa Formation:		
Limestone, light gray, finely crystalline, interbedded with shale, medium gray	94.5	98.5

Soldier Creek Formation:		
Shale, medium gray	98.5	100.5
Shale, medium gray, interbedded with limestone, light gray	100.5	103.6
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, irregularly crystalline, contains Osagia and glauconite	103.6	106.5
Winnebago Member:		
Shale, medium gray	106.5	107.0
Shale, medium gray, contains brown sandstone streaks	107.0	117.1
Taylor Branch Member:		
Limestone, light to medium gray, finely crystalline, contains Osagia	117.1	119.0
Limestone, light gray, finely crystalline, contains glauconite	119.0	120.2
Limestone, light gray, finely crystalline, contains crinoids, interbedded with shale, medium gray	120.2	120.6
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, black	120.6	121.0
Shale, green	121.0	127.5
Shale, red	127.5	139.0
Shale, medium gray	139.0	142.3
Coal, black	142.3	142.6
Shale, medium gray	142.6	152.0

Test Hole #18-81
Otoe County

Location: SW corner sec. 13, T. 8 N., R. 10 E., approximately 93 feet north of south section line and 19 feet east of west section line.
Ground elevation: 1,165.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	4.5
Clay, tan, sandy	4.5	9.0
Clay, dark brown, sandy	9.0	13.5
Clay, tan, sandy	13.5	14.5
Permian System - Big Blue Series - Council Grove Group:		
Red Eagle Formation:		
Bennett Member:		
Shale, very light green to tan, weathered	14.5	19.4
Glenrock Member:		
Limestone, tan to light gray, finely crystalline, weathered, contains fusulinids	19.4	20.5
Limestone, tan, very finely crystalline, weathered, contains abundant Osagia and manganese staining	20.5	21.2
Limestone, tan to medium gray, finely crystalline, contains manganese staining	21.2	22.5
Johnson Formation:		
Shale, green	22.5	24.0
Shale, medium gray	24.0	28.4
Shale, dark green	28.4	29.0
Shale, red mottled gray	29.0	29.7
Shale, medium gray	29.7	30.6
Foraker Formation:		
Long Creek Member:		
Limestone, light greenish gray, very finely crystalline, argillaceous	30.6	33.0
Limestone, light greenish gray to medium gray, very finely crystalline	33.0	35.0
Shale, green	35.0	35.2
Limestone, medium gray, very finely crystalline to lithographic	35.2	37.1
Hughes Creek Member:		
Shale, medium gray	37.1	38.1
Shale, light gray	38.1	39.0
Shale, dark gray	39.0	43.2
Limestone, very dark gray, medium crystalline, pseudo-oolitic, contains abundant Osagia	43.2	45.1
Limestone, medium gray, finely crystalline, contains brachiopods, Osagia, and "black inclusions"	45.1	46.3
Shale, medium gray	46.3	52.8
Limestone, medium gray, finely crystalline, contains abundant brachiopods, interbedded with shale, medium gray	52.8	53.0

Shale, medium gray	53.0	53.5
Limestone, light gray, finely crystalline, contains abundant brachiopods, interbedded with shale, medium gray	53.5	54.5
Shale, light greenish gray	54.5	59.2
Limestone, dark gray, finely crystalline, contains brachiopods and pyrite	59.2	60.0
Shale, very dark gray	60.0	61.7
Limestone, medium gray, variably crystalline, contains Osagia, coral, "black inclusions", and pyrite	61.7	63.2
Shale, medium gray	63.2	63.6
Limestone, medium to dark gray, finely crystalline, contains fusulinids, crinoids, Osagia, and pyrite.	63.6	63.8
Shale, medium gray	63.8	66.5
Limestone, medium to dark gray, finely crystalline, contains brachiopods, crinoids, and Osagia, interbedded with shale, medium gray	66.5	70.2
Shale, black	70.2	71.0
Limestone, medium gray, very finely crystalline, contains coral, crinoids, and Osagia	71.0	72.2
Shale, medium gray	72.2	74.0
Limestone, medium to dark gray, finely crystalline, pseudo-oolitic, contains crinoids and Osagia	74.0	76.0
Shale, medium gray	76.0	76.5
Limestone, medium gray, medium crystalline, contains abundant Osagia	76.5	76.7
Shale, medium gray	76.7	78.2
Shale, black	78.2	78.6
Americus Member:		
Limestone, medium gray, finely crystalline, contains crinoids and pyrite	78.6	79.8
Shale, medium gray	79.8	81.5
Limestone, light gray, very finely crystalline, contains crinoids	81.5	82.0
Limestone, medium gray, very finely crystalline	82.0	82.9
Admire Group:		
West Branch - Hamlin Formations:		
Shale, medium gray	82.9	86.4
Limestone, medium gray, very finely crystalline	86.4	86.7
Shale, medium gray	86.7	88.3
Limestone, light gray, lithographic, interbedded with shale, green	88.3	89.0
Limestone, very light grayish green, very finely crystalline, contains glauconite, interbedded with shale, green, at 91.0 to 92.4 ft	89.0	92.4
Shale, red	92.4	95.0
Shale, red, interbedded with limestone, light gray	95.0	98.3
Limestone, very light grayish green, very finely crystalline, contains glauconite, interbedded with shale, green	98.3	101.0
Shale, red	101.0	104.2
Limestone, medium gray, very finely crystalline, contains brachiopods and crinoids	104.2	104.8

Shale, medium gray	104.8	107.0
Shale, red	107.0	109.5
Shale, grayish green	109.5	110.5
Shale, pale red, interbedded with limestone, light gray	110.5	114.0
Shale, medium gray, interbedded with limestone, light gray	114.0	115.0
Shale, olive	115.0	117.0
Shale, green	117.0	118.0
Shale, olive	118.0	119.5
Shale, gray mottled olive	119.5	120.5
Limestone, dark gray, finely crystalline, contains Osagia, pyrite, and black carbonaceous material	120.5	120.8
Shale, medium gray	120.8	122.0

Test Hole #7-81
Otoe County

Location: NE corner SE NE sec. 14, T. 8 N., R. 10 E., approximately 1,920 feet south of north section line and 19 feet west of east section line.
Ground elevation: 1,124.5 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	6.0
Clay, medium gray, very sandy	6.0	10.0
Clay, tan to medium gray, sandy	10.0	15.0
Clay, tan, sandy	15.0	17.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, medium gray, contains sandstone streaks	17.0	23.0
Shale, light gray, contains sandstone streaks	23.0	32.0
Shale, medium gray	32.0	44.5
Shale, medium gray, sandy	44.5	48.5
Shale, medium greenish gray	48.5	51.0
Shale, green mottled red	51.0	52.0
Shale, red and green	52.0	53.4
Emporia Formation:		
Elmont - Reading Members:		
Limestone, medium gray, finely crystalline, pseudo-oolitic, contains glauconite and pyrite	53.4	54.2
Shale, red	54.2	56.4
Shale, medium gray, interbedded with limestone, medium gray	56.4	56.8
Limestone, light gray, very finely crystalline, contains Osagia and coarsely crystalline calcite streaks	56.8	58.5
Shale, medium gray	58.5	59.8
Limestone, light gray to tan, very finely crystalline, contains brachiopods, fusulinids, Osagia, and glauconite	59.8	62.2
Auburn Formation:		
Shale, light green	62.2	63.5
Shale, red	63.5	71.2
Shale, red mottled green	71.2	71.6
Shale, red	71.6	77.5
Shale, red, very sandy	77.5	81.0
Shale, olive	81.0	83.6
Shale, grayish green	83.6	85.2
Shale, medium gray	85.2	93.3
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains brachiopods, fusulinids, and pyrite	93.3	93.9
Limestone, medium gray, finely crystalline, contains brachiopods, Osagia, "black inclusions," and abundant fusulinids, interbedded with shale, green	93.9	98.2

Soldier Creek Formation:		
Shale, medium gray	98.2	100.7
Shale, light grayish green	100.7	103.2
Burlingame Formation:		
South Fork Member:		
Limestone, light gray to tan, finely crystalline, contains Osagia	103.2	105.1
Winnebago Member:		
Shale, medium gray	105.1	107.8
Shale, medium olive gray	107.8	110.5
Shale, medium gray	110.5	116.1
Taylor Branch Member:		
Limestone, light greenish gray, finely crystalline, contains glauconite, pyrite, and "black inclusions"	116.1	119.9
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, medium greenish gray	119.9	121.2
Shale, black	121.2	122.7
Shale, grayish green	122.7	127.5
Shale, light green	127.5	130.0

Test Hole #2-81
Otoe County

Location: NE corner SE sec. 17, T. 8 N., R. 10 E., approximately 2,578 feet north of south section line and 22 feet west of east section line.
Ground elevation: 1,152.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, yellowish brown, contains gravel	3.0	7.0
Clay, yellowish brown, contains sand and gravel	7.0	10.0
Clay, light brownish gray, slightly silty	10.0	17.0
Sand, coarse, contains gravel	17.0	19.0
Clay, tan, slightly silty	19.0	23.5
Clay, light brown	23.5	24.0
Clay, light brown to light gray	24.0	31.0
Clay, medium gray to tan, silty	31.0	42.0
Clay, medium gray, silty	42.0	47.0
Clay, light to medium gray, silty	47.0	54.5
Clay, light greenish gray, silty	54.5	59.5
Clay, medium greenish gray, silty	59.5	64.3
Clay, medium to dark gray, silty	64.3	68.0
Clay, medium gray to greenish gray	68.0	79.5
Sand, fine to medium, contains gravel	79.5	89.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, pale olive	89.0	93.0
Shale, light greenish gray	93.0	94.0
Shale, light to medium gray	94.0	103.5
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains crinoids, fusulinids, brachiopods and Osagia	103.5	107.4
Soldier Creek Formation:		
Shale, medium gray	107.4	108.5
Burlingame Formation:		
South Fork Member:		
Limestone, medium gray to tan, finely crystalline	108.5	110.2
Limestone, light gray, finely crystalline, pseudo-oolitic, contains Osagia and glauconite	110.2	114.2
Winnebago Member:		
Shale, light gray	114.2	117.0
Shale, medium gray	117.0	120.1
Shale, light gray	120.1	126.2
Taylor Branch Member:		
Limestone, medium gray to tan, finely crystalline, contains fusulinids and Osagia	126.2	127.5
Shale, light gray	127.5	128.6
Limestone, tan, finely crystalline, contains fusulinids, Osagia, glauconite and stylolites	128.6	131.0

Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, light greenish gray mottled olive.....	131.0	132.8
Shale, light gray.....	132.8	150.5
Shale, light gray, contains brown sandstone streaks and pyrite.....	150.5	151.0
Shale, light gray, contains brown sandstone streaks and black carbonaceous material.....	151.0	163.4
Shale, light gray, contains brown sandstone streaks.	163.4	179.3
Sandstone, medium to dark gray.....	179.3	180.1
Shale, light gray, silty.....	180.1	192.0
Shale, medium gray mottled tan, contains brown sandstone streaks.....	192.0	198.4
Shale, light gray, contains brown sandstone streaks and trace of coal at 209.0 ft.....	198.4	212.0
Limestone, medium gray, very finely crystalline, contains brachiopods, crinoids, and pyrite.....	212.0	212.2
Shale, light gray, contains brown sandstone streaks.	212.2	214.3
Howard Formation:		
Limestone, medium gray, very finely crystalline, contains crinoids and abundant fusulinids.....	214.3	216.2
Limestone, light gray, very finely crystalline, contains crinoids, fusulinids, Osagia, and pyrite.	216.2	222.4
Severy Formation:		
Shale, black, carbonaceous.....	222.4	222.7
Shale, light gray.....	222.7	227.0

Test Hole #1-81
Otoe County

Location: SW SW NW sec. 19, T. 8 N., R. 10 E., approximately 1,950 feet south of north section line and 20 feet east of west section line.
Ground elevation: 1,182.5 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	5.0
Clay, light yellowish brown, moderately silty	5.0	10.0
Clay, light yellowish brown, contains gravel	10.0	23.0
Clay, dark gray, slightly silty	23.0	37.5
Clay, light greenish gray	37.5	48.0
Clay, olive, silty	48.0	52.5
Clay, medium to dark gray, slightly silty	52.5	66.0
Clay, medium to dark gray, slightly silty, contains black carbonaceous material	66.0	69.0
Clay, medium gray, slightly silty	69.0	83.0
Clay, light gray, slightly silty	83.0	86.0
Clay, medium gray, slightly silty	86.0	88.0
Clay, light gray, slightly silty	88.0	92.0
Clay, light gray, sandy, silty	92.0	96.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, light greenish gray	96.0	97.2
Limestone, medium gray, very finely crystalline, contains fusulinids	97.2	97.8
Shale, pale olive	97.8	99.0
Shale, light reddish gray	99.0	100.1
Emporia Formation:		
Elmont Member:		
Limestone, medium gray to tan, finely crystalline, pseudo-oolitic, contains bryozoans, crinoids and Osagia	100.1	102.8
Shale, light reddish gray	102.8	103.7
Limestone, very light gray, finely crystalline, contains Osagia	103.7	105.4
Harveyville Member:		
Shale, light to medium gray	105.4	106.9
Reading Member:		
Limestone, light gray, finely crystalline, contains crinoids, brachiopods, and Osagia	106.9	110.0
Shale, light to medium gray	110.0	110.2
Limestone, medium gray, finely crystalline, pseudo-oolitic in part, contains brachiopods and Osagia	110.2	113.0
Auburn Formation:		
Shale, light greenish gray	113.0	114.0
Shale, red	114.0	123.2
Shale, red mottled tan	123.2	126.0
Shale, light greenish gray mottled olive	126.0	130.0

Shale, medium to dark gray	130.0	138.2
Wakarusa Formation:		
Limestone, medium to dark gray, finely crystalline, contains fusulinids, interbedded with shale, medium gray	138.2	140.6
Limestone, light gray, finely crystalline	140.6	142.7
Soldier Creek Formation:		
Shale, medium gray	142.7	145.2
Limestone, medium gray, finely crystalline, contains fusulinids, crinoids, Osagia, and "black inclusions", interbedded with shale, medium gray	145.2	145.8
Shale, reddish gray	145.8	147.2
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, very finely crystalline, contains crinoids	147.2	150.4
Shale, dark gray	150.4	151.5
Limestone, light gray to tan, finely crystalline, contains Osagia	151.5	152.1
Winnebago Member:		
Shale, medium gray	152.1	155.0
Shale, light gray	155.0	156.2
Shale, medium gray	156.2	160.1
Taylor Branch Member:		
Limestone, medium gray, finely crystalline	160.1	161.0
Limestone, medium gray, variably crystalline, contains fusulinids, crinoids, brachiopods, pyrite, and "black inclusions"	161.0	161.6
Shale, light greenish gray	161.6	162.0
Shale, light to medium gray	162.0	163.5
Limestone, light gray, very finely crystalline, contains brachiopods and glauconite	163.5	164.8
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, pale olive	164.8	167.0
Shale, red mottled green	167.0	167.2
Shale, light greenish gray	167.2	170.0
Shale, reddish gray	170.0	178.3
Shale, reddish gray, interbedded with limestone, light greenish gray	178.3	182.9
Shale, light greenish gray	182.9	183.0
Limestone, light greenish gray, finely crystalline	183.0	183.9
Shale, pale olive	183.9	184.5
Shale, light gray	184.5	194.0
Coal, black	194.0	194.5
Shale, light greenish gray	194.5	213.3
Shale, light greenish gray, interbedded with thin limestone streaks	213.3	213.5
Shale, medium gray	213.5	240.3
Shale, light gray, silty	240.3	242.0
Howard Formation:		
Limestone, medium to dark gray, finely crystalline, contains abundant crinoids	242.0	243.3
Shale, dark gray	243.3	245.2

Limestone, light to medium gray, very finely crystalline, contains crinoids, fusulinids, pyrite, and "black inclusions"	245.2	250.8
Severy Formation:		
Shale, medium gray	250.8	251.0
Coal, black	251.0	251.4
Shale, medium gray	251.4	257.0

Test Hole #3-81
Otoe County

Location: NW corner sec. 21, T. 8 N., R. 10 E., approximately 138 feet south of north section line and 18 feet east of west section line.
Ground elevation: 1,170.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	6.0
Clay, brown	6.0	18.0
Clay, light brown to tan, sandy	18.0	22.0
Clay, gray to tan, sandy	22.0	25.0
Clay, tan, very sandy	25.0	32.0
Clay, brown, very sandy	32.0	44.0
Clay, light brown, sandy	44.0	51.0
Sand, fine	51.0	54.5
Clay, light brown, very sandy	54.5	59.0
Clay, light gray, silty	59.0	62.5
Clay, medium gray, very sandy	62.5	71.0
Clay, dark gray	71.0	76.5
Clay, light gray, silty, sandy	76.5	88.0
Clay, greenish gray, sandy	88.0	95.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, red	95.5	98.5
Shale, olive, mottled yellow and red	98.5	100.3
Shale, olive	100.3	103.0
Shale, medium gray	103.0	112.8
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains crinoids, fusulinids, brachiopods, and pyrite	112.8	115.0
Limestone, medium gray, finely crystalline, contains fusulinids, pyrite, and "black inclusions"	115.0	117.2
Soldier Creek Formation:		
Shale, medium gray	117.2	118.3
Limestone, light gray to tan, very finely crystalline, interbedded with shale, light greenish gray	118.3	120.0
Shale, reddish gray	120.0	121.1
Shale, light greenish gray mottled red	121.1	121.8
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, very finely crystalline, contains Osagia and glauconite	121.8	123.8
Winnebago Member:		
Shale, light greenish gray	123.8	127.0
Shale, light gray	127.0	130.0
Shale, medium gray	130.0	135.1
Taylor Branch Member:		
Limestone, medium gray, finely crystalline	135.1	135.6
Shale, light gray	135.6	136.8

Limestone, light gray, very finely crystalline, contains glauconite	136.8	137.5
Limestone, light greenish gray, finely crystalline, contains abundant glauconite	137.5	139.3
Scranton Formation:		
Silver Lake - White Cloud Members:		
Sandstone, tan, interbedded with shale, greenish gray	139.3	141.8
Shale, black, carbonaceous	141.8	142.2
Shale, light greenish gray	142.2	145.0
Shale, red	145.0	149.5
Shale, green mottled red	149.5	151.0
Shale, red mottled green	151.0	155.3
Shale, green mottled red	155.3	155.9
Shale, red mottled green	155.9	158.5
Shale, olive mottled red	158.5	159.5
Shale, medium gray	159.5	167.2
Coal, black	167.2	167.5
Shale, medium gray	167.5	182.0

Test Hole #20-81
Otoe County

Location: NW NE NW sec. 21, T. 8 N., R. 10 E., approximately 12 feet south of north section line and 1,362 feet east of west section line.
Ground elevation: 1,213.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	4.0
Clay, tan, sandy	4.0	8.5
Clay, olive, sandy	8.5	19.0
Clay, medium gray, sandy	19.0	22.0
Clay, brown, sandy	22.0	34.0
Sand, medium, clayey	34.0	41.0
Sand, coarse, and gravel	41.0	43.0
Gravel, clayey	43.0	47.0
Clay, medium gray, sandy, very silty	47.0	62.0
Clay, light gray, sandy	62.0	71.0
Clay, reddish gray, sandy	71.0	77.0
Clay, reddish gray, very sandy	77.0	85.8
Permian System - Big Blue Series - Council Grove Group:		
Grenola Formation:		
Burr Member:		
Limestone, light gray, very finely crystalline, pseudo-oolitic, contains brachiopods	85.8	88.7
Roca Formation:	88.7	92.5
Shale, light grayish green	92.5	94.0
Shale, very light gray	94.0	97.6
Shale, medium grayish green	97.6	101.0
Shale, red mottled green	101.0	101.8
Shale, red mottled gray	101.8	104.0
Shale, medium gray, contains thin limestone streaks	104.0	106.5
Shale, light gray	106.5	107.4
Shale, red	107.4	108.8
Shale, medium gray	108.8	109.0
Limestone, very light gray, lithographic	109.0	110.5
Shale, reddish gray	110.5	112.7
Shale, grayish green		
Red Eagle Formation:		
Howe Member:	112.7	113.3
Shale, medium gray, limy	113.3	115.2
Shale, grayish tan	115.2	118.4
Limestone, medium gray to tan, variably crystalline, pseudo-oolitic, contains Osagia		
Bennett Member:	118.4	121.0
Shale, light gray	121.0	124.0
Shale, gray mottled olive	124.0	124.7
Shale, black	124.7	125.5
Shale, medium gray	125.5	126.5
Shale, black		

Glenrock Member:		
Limestone, medium to dark gray, very finely crystalline, contains abundant black carbonaceous material	126.5	128.4
Johnson Formation:		
Shale, light grayish green	128.4	129.4
Shale, medium gray	129.4	130.1
Limestone, medium gray, finely crystalline, interbedded with shale, medium gray	130.1	131.1
Shale, medium greenish gray	131.1	137.2
Shale, red	137.2	138.2
Shale, medium gray	138.2	139.0
Foraker Formation:		
Long Creek Member:		
Limestone, light gray, very finely crystalline	139.0	141.5
Limestone, medium gray, very finely crystalline, contains glauconite	141.5	142.5
Hughes Creek Member:		
Shale, light gray	142.5	145.0
Shale, medium gray	145.0	152.0
Limestone, medium to dark gray, variably crystalline, pseudo-oolitic, contains brachiopods, Osagia, and "black inclusions"	152.0	154.5
Shale, medium gray	154.5	162.0
Shale, light gray	162.0	167.8
Limestone, medium gray, finely crystalline	167.8	168.5
Shale, black	168.5	170.1
Limestone, medium gray, finely crystalline, contains fusulinids, brachiopods, Osagia, and "black inclusions	170.1	171.9
Shale, dark gray	171.9	176.5
Shale, medium gray	176.5	178.8
Shale, medium gray, interbedded with limestone, light gray	178.8	180.0
Shale, dark gray	180.0	180.4
Limestone, medium gray, finely crystalline, contains brachiopods, Osagia, and "black inclusions	180.4	181.5
Shale, medium gray	181.5	183.0
Limestone, medium gray, finely crystalline, pseudo-oolitic, contains brachiopods, bryozoans, crinoids, fusulinids, and Osagia	183.0	185.0
Shale, medium gray	185.0	188.0
Shale, black	188.0	188.4
Americus Member:		
Limestone, dark gray, very finely crystalline	188.4	189.7
Shale, dark gray	189.7	191.3
Limestone, medium gray, finely crystalline, contains coral, crinoids, and brachiopods	191.3	192.4
Admire Group:		
Hamlin Formation:		
Shale, medium gray	192.4	196.0
Limestone, medium gray, finely crystalline, pseudo-oolitic, contains brachiopods and glauconite	196.0	197.0

Test Hole #21-81
Otoe County

Location: SW corner NW sec. 21, T. 8 N., R. 10 E., approximately 2,604 feet south of north section line and 30 feet east of west section line.
Ground elevation: 1,236.0 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	5.0
Clay, red, silty	5.0	9.5
Clay, tan, sandy	9.5	13.0
Clay, tan, very sandy	13.0	22.0
Clay, olive gray, sandy	22.0	29.5
Clay, brown to gray, sandy	29.5	41.0
Clay, olive gray, sandy	41.0	49.0
Sand, fine, silty	49.0	61.5
Clay, gray, very sandy, contains gravel	61.5	72.0
Clay, dark gray, very sandy, contains gravel	72.0	85.0
Clay, light gray, very sandy	85.0	92.0
Clay, light brown to gray, sandy	92.0	108.0
Clay, light gray, sandy	108.0	112.0
Clay, medium gray, sandy	112.0	128.0
Clay, dark gray, sandy	128.0	143.0
Clay, medium gray	143.0	148.0
Clay, dark gray	148.0	152.5
Clay, medium gray, sandy	152.5	158.0
Clay, medium gray	158.0	169.0
Clay, dark gray	169.0	175.0
Clay, light gray, sandy	175.0	181.4
Sand, coarse, contains gravel	181.4	183.0
Clay, greenish gray	183.0	190.0
Permian System - Big Blue Series - Admire Group:		
West Branch Formation:		
Shale, light green	190.0	191.6
Limestone, light gray to green, very finely crystalline, contains bryozoans, brachiopods, and crinoids	191.6	192.1
Shale, light gray	192.1	199.0
Shale, medium gray	199.0	200.0
Shale, dark gray	200.0	202.6
Falls City Formation:		
Limestone, light gray, finely crystalline	202.6	203.5
Shale, medium gray	203.5	203.7
Limestone, light gray, very finely crystalline	203.7	207.2
Shale, medium gray	207.2	210.4
Limestone, medium to dark gray, finely crystalline	210.4	212.0
Limestone, light gray, very finely crystalline, contains Osagia and "black inclusions"	212.0	213.5

Onaga Formation:		
Hauxby - Towle Members:		
Shale, medium greenish gray	213.5	215.5
Shale, light grayish green	215.5	218.5
Shale, medium gray	218.5	220.5
Shale, red mottled green	220.5	223.0
Limestone, bluish gray to very light gray, very finely crystalline, interbedded with shale, red	223.0	224.0
Shale, red	224.0	229.0
Shale, olive	229.0	231.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, very light gray, variably crystalline, contains fusulinids	231.5	233.6
Pony Creek - Plumb Members:		
Shale, medium gray	233.6	236.2
Shale, red	236.2	241.2
Limestone, light gray, finely crystalline, interbedded with shale, red	241.2	241.5
Shale, red	241.5	244.5
Shale, light grayish green	244.5	245.5
Shale, dark gray	245.5	250.4
Nebraska City Member:		
Limestone, dark gray, very finely crystalline, contains brachiopods, fusulinids, black carbonaceous material, and pyrite	250.4	251.0
Stoler - Root Formations:		
Shale, black	251.0	252.5
Coal, black	252.5	252.6
Shale, medium gray	252.6	259.0
Shale, red mottled green	259.0	261.5
Limestone, very light gray to white, very finely crystalline to lithographic, contains fusulinids and crinoids	261.5	265.8
Shale, red	265.8	267.0
Shale, olive	267.0	272.5
Shale, medium gray	272.5	287.0

Test Hole #23-A-61
Otoe County

Location: SE SE SE sec. 1, T. 8 N., R. 11 E., approximately 12 feet north of south section line and 460 feet west of east section line.
Ground elevation: 1,229.2 ft. (Dunbar 7.5 min. quadrangle)
Depth to water: 9.94 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Silt, moderately clayey, light gray, trace of very fine sand, some dark stain, below 2.0 ft. brownish gray	0.0	6.5
Silt, moderately clayey, grayish brown, trace of very fine sand, some iron stain, below 7.8 ft. dark grayish brown	6.5	13.4
Silt, very clayey, brownish gray, below 14.6 ft. gray, below 15.0 ft. trace of very fine sand	13.4	17.8
Silt, very clayey, light gray to light brownish gray, trace of very fine sand	17.8	20.0
Till: clay, silty, sandy to gravelly, moderately calcareous, some iron stain, limy nodules, below 24.5 ft. very calcareous	20.0	22.0
Gravel, sandy, coarse sand to coarse gravel	22.0	26.0
Till: clay, silty, sandy to gravelly, very calcareous, pale brown to yellowish brown, many limestone pebbles	26.0	30.0
Till: clay, silty, sandy, few gravel grains, very calcareous, light gray to light brownish gray, few limy grains, below 35.4 ft. some marly areas	30.0	40.5
Till: clay, silty, sandy to gravelly, very calcareous, light gray to yellowish brown, iron stain and iron fragments, below 45.0 ft. light brownish gray	40.5	60.0
Till: clay, silty, sandy to gravelly, very calcareous, light brownish gray to olive yellow, limy areas, contains few pebbles	60.0	62.0
Sand, gravelly, coarse sand to coarse gravel	62.0	64.0
Till: clay, silty, sandy to gravelly, very calcareous, light gray to olive yellow, some limy grains, some iron stain, below 65.0 ft. light gray to brownish yellow	64.0	65.7
Silt, slightly clayey, moderately calcareous, olive.	65.7	66.1
Till: clay, silty, sandy, very calcareous, bluish gray, few gravel and limy grains	66.1	75.6
Sand and gravel, coarse sand to coarse gravel, principally shale, sandstone, limestone fragments	75.6	76.1
Till: clay, silty, sandy, few gravel grains, very calcareous, bluish gray	76.1	78.8

Sand, medium to coarse, some very coarse.....	78.8	79.1
Till: clay, silty, sandy, few gravel grains, very calcareous, bluish gray, from 83.3 to 83.8 ft. interbedded silt lens, very sandy, below 83.8 ft. the till is gravelly.....	79.1	87.3
Sand, fine to coarse, contains limy grains.....	87.3	88.8
Till: clay, silty, sandy to gravelly, very calcareous.....	88.8	92.9
Gravel, very fine sand to coarse gravel, principally limestone, shale, sandstone, shell fragments.....	92.9	94.1
Till: clay, silty, sandy to gravelly, very calcareous, bluish gray.....	94.1	94.6
Sand, very fine to medium, limy grains.....	94.6	96.6
Till: clay, silty, sandy to gravelly, very calcareous, bluish gray.....	96.6	97.2
Sand, silty, sand is very fine to medium, trace of coarse, interbedded silt lens.....	97.2	100.0
Sand, very fine to medium, trace of coarse, limy grains.....	100.0	105.2
Silt, very sandy, slightly clayey, bluish gray, limy grains.....	105.2	106.1
Till: clay, silty, sandy, gravelly, very calcareous, bluish gray.....	106.1	106.8
Gravel, sandy, fine sand to coarse gravel, much reworked limestone and shale fragments.....	106.8	115.6
Sand, gravelly, medium sand to fine gravel, much reworked limestone and dark minerals below 125.8 ft.....	115.6	129.3
Till: clay, silty, sandy, gravelly, very calcareous, bluish gray.....	129.3	140.0
Gravel, sandy, fine sand to medium gravel.....	140.0	152.5
Till: clay, silty, sandy, gravelly, very calcareous, dark gray.....	152.5	153.9
Boulder: limestone, greenish gray.....	153.9	154.2
Till: clay, silty, sandy, gravelly, very calcareous, olive, below 155.0 ft. greenish gray, below 160.0 ft. slightly calcareous.....	154.2	166.1
Silt, very sandy, moderately clayey, bluish green, sand is very fine to fine.....	166.1	170.0
Till: clay, silty, sandy, gravelly, very calcareous, bluish gray.....	170.0	172.6
Sand, medium to very coarse, trace of gravel, much reworked limestone and dark minerals.....	172.6	175.0
Clay, silty, moderately calcareous, bluish gray with gray trace of fine sand, below 177.4 ft. very calcareous, below 185.0 ft. very sandy.....	175.0	190.0
Clay, silty, moderately sandy, very calcareous, bluish gray.....	190.0	195.5
Clay, silty, very calcareous, dark gray, below 201.4 ft. slightly calcareous, grayish brown.....	195.5	203.0

Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Pillsbury - Stotler Formations:		
Limestone, light greenish gray, finely crystalline, vuggy, contains crinoids.....	203.0	206.0
Shale, light greenish gray and dark reddish brown...	206.0	209.0
Limestone, pale yellow, finely crystalline, iron stained.....	209.0	210.0
Shale, light greenish gray, pale yellow and dark reddish brown.....	210.0	215.0
Shale, light gray, very finely micaceous, sandy.....	215.0	217.7
Sandstone, dark bluish gray, moderately calcareous, hard.....	217.7	218.3
Sandstone, soft, light gray, very fine grained, shaly.....	218.3	235.0
Shale, light gray, sandy.....	235.0	240.0
Shale, light to medium gray.....	240.0	246.8
Zeandale Formation:		
Maple Hill Member:		
Limestone, dark gray, finely crystalline.....	246.8	248.6
Wamego Member:		
Shale, light gray.....	248.6	252.8
Tarkio Member:		
Limestone, light gray, very finely crystalline.....	252.8	253.5
Shale, light greenish gray and dark reddish brown...	253.5	254.4
Limestone, light brown, finely crystalline, contains calcite veins.....	254.4	255.9
Limestone, as above, much interbedded light greenish gray shale.....	255.9	258.9
Willard Formation:		
Shale, light gray to white, slightly sandy.....	258.9	259.9
Shale, light gray, very finely micaceous, sandy with some black carbonaceous material.....	259.9	260.1
Shale, black, "coal-like" material.....	260.1	260.6

Test Hole #14-81
Otoe County

Location: NW corner sec. 2, T. 8 N., R. 11 E., approximately 19 feet south of north section line and 117 feet east of west section line.
Ground elevation: 1,190.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, tan, sandy	3.0	8.5
Clay, medium olive gray, sandy	8.5	16.0
Clay, tan to brown, sandy	16.0	27.0
Clay, tan, sandy	27.0	29.0
Clay, olive, sandy	29.0	39.0
Clay, dark gray, sandy	39.0	42.0
Clay, reddish gray, sandy	42.0	47.5
Clay, dark reddish gray, sandy	47.5	50.0
Clay, medium gray, sandy	50.0	53.0
Clay, light grayish green, sandy	53.0	70.0
Clay, light grayish green, very sandy	70.0	71.0
Clay, tan, sandy	71.0	77.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, olive	77.0	82.0
Shale, medium gray	82.0	84.7
Shale, medium gray, limy	84.7	89.0
Shale, medium gray	89.0	93.3
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light gray, very finely crystalline	93.3	96.0
Shale, red	96.0	97.1
Limestone, light gray, finely crystalline, contains Osagia	97.1	99.2
Shale, medium gray	99.2	100.0
Limestone, light gray to tan, very finely crystalline, weathered, contains crinoids, Osagia, and glauconite	100.0	102.8
Auburn Formation:		
Shale, dark gray	102.8	103.8
Shale, medium grayish green	103.8	104.8
Shale, red	104.8	118.6
Shale, red mottled olive	118.6	120.0
Shale, medium gray	120.0	124.5
Coal, black	124.5	124.6
Shale, medium gray	124.6	133.6

Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains brachiopods and black carbonaceous material.....	133.6	134.8
Shale, medium gray.....	134.8	135.0
Limestone, medium to dark gray, finely crystalline, contains brachiopods and "black inclusions".....	135.0	138.0
Soldier Creek Formation:		
Shale, medium gray.....	138.0	140.8
Limestone, light gray, very finely crystalline, pseudo-oolitic, contains brachiopods.....	140.8	141.0
Shale, red.....	141.0	144.0
Shale, gray mottled red.....	144.0	145.0
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, finely crystalline, pseudo-oolitic in part, contains glauconite and abundant Osagia.....	145.0	147.0
Limestone, light gray, very finely crystalline, contains Osagia.....	147.0	147.6
Winnebago Member:		
Shale, green.....	147.6	148.1
Shale, red.....	148.1	150.8
Shale, medium gray.....	150.8	160.1
Taylor Branch Member:		
Limestone, medium gray, medium crystalline, contains coral, brachiopods, bryozoans, gastropods, and pyrite.....	160.1	161.4
Shale, medium gray.....	161.4	162.8
Limestone, medium to dark gray, medium crystalline, pseudo-oolitic, contains crinoids and Osagia.....	162.8	163.0
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, light green.....	163.0	163.8
Shale, light gray.....	163.8	164.8
Shale, light gray, interbedded with limestone, light gray.....	164.8	167.5
Coal, black.....	167.5	169.0
Shale, light gray.....	169.0	170.5
Shale, light gray, interbedded with limestone, medium gray.....	170.5	171.5
Shale, light greenish gray.....	171.5	175.4
Shale, red.....	175.4	180.7
Limestone, light tan to gray, lithographic, interbedded with shale, red.....	180.7	182.0

Test Hole #8-81
Otoe County

Location: SW NW SW sec. 7, T. 8 N., R. 11 E., approximately 1,700 feet north of south section line and 20 feet east of west section line.
Ground elevation: 1,093.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	4.0
Clay, light brown, sandy	4.0	11.5
Clay, light brown, very sandy	11.5	15.5
Clay, brown, sandy, silty	15.5	21.0
Clay, brown, sandy	21.0	26.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, red, very sandy	26.0	27.2
Shale, red, and siltstone, red	27.2	32.7
Shale, olive	32.7	35.0
Shale, greenish gray	35.0	36.8
Shale, medium gray	36.8	41.2
Shale, medium gray, contains abundant pyrite	41.2	47.2
Wakarusa Formation:		
Shale, medium gray, interbedded with limestone, gray	47.2	48.1
Limestone, medium gray, finely crystalline, contains brachiopods	48.1	49.4
Shale, black	49.4	49.5
Limestone, medium gray, finely crystalline, contains brachiopods	49.5	50.6
Shale, black	50.6	50.8
Limestone, medium gray, finely crystalline, contains fusulinids and brachiopods	50.8	51.9
Soldier Creek Formation:		
Shale, light gray	51.9	53.4
Limestone, light gray to tan, very finely crystalline, contains fusulinids	53.4	53.9
Shale, red	53.9	55.0
Shale, red mottled green	55.0	56.1
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, very finely crystalline, contains Osagia	56.1	57.0
Limestone, light greenish gray, very finely crystalline, contains fusulinids, Osagia, and glauconite.	57.0	59.6
Winnebago Member:		
Shale, light green	59.6	60.2
Shale, light gray	60.2	62.3
Shale, olive gray	62.3	63.0
Shale, medium gray	63.0	71.2
Shale, medium to very dark gray	71.2	71.4

Taylor Branch Member:		
Limestone, medium to dark gray, finely crystalline, contains Osagia	71.4	71.6
Limestone, medium gray, very finely crystalline, contains "black inclusions" and pyrite	71.6	73.0
Limestone, medium gray, finely crystalline, contains fusulinids, Osagia, glauconite, pyrite, and "black inclusions"	73.0	74.2
Limestone, light greenish gray, very finely crystalline, contains Osagia and glauconite	74.2	75.1
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, light grayish green	75.1	75.6
Shale, dark gray	75.6	77.5
Shale, medium gray	77.5	79.0
Shale, light green	79.0	84.4
Shale, red	84.4	87.8
Shale, red, interbedded with limestone, gray	87.8	90.1
Shale, red mottled green	90.1	90.3
Shale, red	90.3	92.0
Shale, red mottled green	92.0	93.5
Shale, light gray	93.5	95.1
Limestone, medium greenish gray, medium crystalline, contains abundant brachiopods	95.1	95.4
Shale, medium gray	95.4	96.5
Coal, black	96.5	97.0
Shale, light greenish gray	97.0	102.4
Shale, black	102.4	102.6
Shale, light gray	102.6	122.0

Test Hole #17-81
Otoe County

Location: SE SW SW sec. 8, T. 8 N., R. 11 E., approximately 26 feet north of south section line and 1,150 feet east of west section line.
Ground elevation: 1,063.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	6.0
Clay, brown, sandy	6.0	15.0
Clay, olive gray, sandy	15.0	17.5
Clay, tan to gray, sandy	17.5	23.0
Clay, olive, very sandy	23.0	26.0
Clay, medium gray, sandy	26.0	26.5
Sand, medium to coarse	26.5	29.0
Clay, medium gray, very sandy	29.0	34.5
Sand, medium to coarse	34.5	35.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Burlingame Formation:		
Winnebago Member:		
Shale, red	35.0	37.2
Limestone, yellow to tan, finely crystalline, weathered, contains manganese staining	37.2	37.4
Shale, medium gray to tan	37.4	39.0
Shale, red	39.0	44.5
Shale, medium gray	44.5	47.4
Taylor Branch Member:		
Limestone, light gray, finely crystalline, pseudo-oolitic, contains bryozoans and Osagia	47.4	50.2
Scranton Formation:		
Silver Lake Member:		
Shale, medium gray	50.2	51.0
Shale, green	51.0	51.6
Shale, red	51.6	60.5
Shale, green mottled red	60.5	61.5
Shale, medium gray	61.5	65.4
Rulo Member:		
Limestone, medium gray, finely crystalline	65.4	66.3
Cedarvale Member:		
Shale, medium gray	66.3	67.0
Shale, black	67.0	68.1
Shale, medium gray	68.1	73.3
Shale, green	73.3	74.3
Shale, red	74.3	75.1
Shale, green mottled red	75.1	77.1

Happy Hollow Member:		
Limestone, light greenish gray, finely crystalline, silty, contains fusulinids, bryozoans, Osagia and glauconite.....	77.1	79.3
Limestone, tan to light greenish gray, finely crystalline, contains crinoids and Osagia.....	79.3	80.4
White Cloud Member:		
Shale, red mottled olive.....	80.4	82.5
Shale, olive.....	82.5	83.5
Shale, light greenish gray.....	83.5	86.5
Shale, medium greenish gray.....	85.4	88.0
Shale, medium gray, sandy.....	88.0	102.0
Shale, medium gray.....	102.0	122.0
Shale, medium gray, contains brown sandstone streaks	122.0	137.0

Test Hole #22-81
Otoe County

Location: SE corner sec. 8, T. 8 N., R. 11 E., approximately 136 feet north of south section line and 20 feet west of east section line.
Ground elevation: 1,071.5 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	5.0
Silt, black	5.0	8.0
Clay, medium gray	8.0	13.0
Clay, green	13.0	23.0
Clay, medium gray	23.0	30.5
Clay, greenish gray, silty	30.5	73.5
Sand, medium to coarse, and gravel, medium	73.5	78.6
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Nebraska City Member:		
Limestone, medium greenish gray, finely crystalline, contains brachiopods and glauconite	78.6	79.5
Pillsbury - Root Formations:		
Shale, black	79.5	81.2
Shale, medium greenish gray	81.2	87.4
Shale, red	87.4	90.3
Shale, red, interbedded with limestone, gray	90.3	93.7
Limestone, light gray, very finely crystalline, contains fusulinids	93.7	94.2
Shale, light greenish gray	94.2	96.4
Limestone, medium gray, finely crystalline, interbedded with shale, medium gray	96.4	98.5
Shale, grayish olive	98.5	100.7
Shale, medium gray	100.7	128.9
Sandstone, gray, contains black carbonaceous material	128.9	129.9
Shale, medium gray	129.0	147.0
Shale, medium gray, contains pyrite	147.0	152.0
Shale, medium gray	152.0	158.6
Zeandale Formation:		
Maple Hill Member:		
Limestone, medium gray, very finely crystalline, contains brachiopods	158.6	160.2
Wamego Member:		
Shale, medium gray	160.2	163.8
Tarkio Member:		
Limestone, medium gray, very finely crystalline, contains brachiopods	163.8	164.5
Shale, medium greenish gray	164.5	167.0
Shale, dark gray	167.0	167.2

Limestone, medium gray, very finely crystalline.....	167.2	168.6
Limestone, light gray, finely crystalline, contains abundant brachiopods, interbedded with shale, green.....	168.6	168.9
Willard Formation:		
Shale, very dark gray.....	168.9	170.1
Shale, medium gray.....	170.1	171.0

Test Hole #15-81
Otoe County

Location: NE NW NW sec. 10, T. 8 N., R. 11 E., approximately 28 feet south of north section line and 1,036 feet east of west section line.
Ground elevation: 1,109.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	5.0
Clay, black, sandy	5.0	13.0
Clay, dark greenish gray, sandy	13.0	22.0
Clay, green, sandy	22.0	32.5
Clay, medium gray, sandy	32.5	37.0
Clay, dark gray	37.0	48.0
Clay, light gray	48.0	68.5
Clay, light gray, sandy	68.5	96.0
Clay, light gray, contains sand, coarse, and gravel.	96.0	106.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Stoler Formation:		
Dry Member:		
Shale, light greenish gray	106.0	107.3
Dover Member:		
Limestone, dark gray, finely crystalline, pseudo-oolitic in part, contains crinoids and "black inclusions"	107.3	108.0
Pillsbury Formation:		
Shale, light gray	108.0	129.2
Zeandale Formation:		
Maple Hill Member:		
Limestone, dark gray, finely crystalline, contains crinoids, brachiopods, black carbonaceous material, and pyrite	129.2	130.8
Wamego Member:		
Shale, medium gray	130.8	134.9
Tarkio Member:		
Limestone, tan, lithographic	134.9	135.1
Shale, medium gray	135.1	136.1
Limestone, light gray, finely crystalline, contains Osagia	136.1	138.6
Willard Formation:		
Siltstone, green, very sandy	138.6	146.4
Sandstone, grayish green	146.4	147.5
Shale, medium gray	147.5	169.2
Limestone, medium gray, finely crystalline, contains brachiopods and coral	169.2	174.8
Coal, black	174.8	175.0
Limestone, medium gray, finely crystalline, contains pyrite	175.0	175.2
Shale, light grayish green	175.2	179.0

Emporia Formation:		
Elmont - Reading Members:		
Limestone, light gray to tan, very finely crystalline, contains Osagia and abundant pyrite.....	179.0	180.0
Shale, medium gray, interbedded with limestone, grayish green.....	180.0	181.0
Shale, reddish gray.....	181.0	181.6
Shale, medium gray.....	181.6	182.0
Limestone, light gray to tan, very finely crystalline, contains Osagia.....	182.0	183.7
Shale, medium gray.....	183.7	185.1
Limestone, light gray, very finely crystalline, contains brachiopods, Osagia, and glauconite.....	185.1	187.7
Auburn Formation:		
Shale, green mottled red.....	187.7	188.0
Shale, red mottled green.....	188.0	192.0
Shale, red.....	192.0	197.0
Shale, red mottled olive.....	197.0	204.3
Shale, olive.....	204.3	205.0
Shale, light gray.....	205.0	206.0
Shale, medium gray.....	206.0	212.0

Test Hole #16-81
Otoe County

Location: NW corner SW sec. 18, T. 8 N., R. 11 E., approximately 2,551 feet north of south section line and 20 feet east of west section line.
Ground elevation: 1,087.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, brown, sandy	3.0	9.5
Clay, dark brown, very sandy	9.5	14.5
Clay, tan, sandy	14.5	33.0
Sand, medium to coarse, contains gravel	33.0	37.0
Clay, olive gray	37.0	48.5
Clay, olive gray, very sandy	48.5	58.0
Sand, coarse, contains gravel	58.0	67.7
Permian System - Big Blue Series - Admire Group:		
Onaga Formation:		
Shale, tan, weathered	67.7	68.2
Shale, light bluish green	68.2	69.5
Shale, dark red	69.5	69.7
Limestone, light gray, very finely crystalline	69.7	71.2
Shale, red	71.2	73.0
Shale, red mottled olive	73.0	77.5
Shale, medium gray	77.5	80.3
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light gray, finely crystalline	80.3	83.5
Pony Creek - Plumb Members:		
Shale, light gray	83.5	84.0
Shale, light green	84.0	85.0
Shale, red mottled green	85.0	86.7
Shale, light green mottled red	86.7	88.4
Sandstone, medium greenish gray	88.4	90.0
Shale, red	90.0	93.4
Shale, green	93.4	96.5
Shale, medium gray	96.5	100.4
Nebraska City Member:		
Limestone, medium gray, medium crystalline, contains brachiopods	100.4	102.6
Pillsbury - Root Formations:		
Coal, black	102.6	103.4
Shale, green	103.4	112.1
Shale, red mottled green	112.1	113.1
Limestone, medium gray, medium crystalline, contains Osagia	113.1	113.6
Shale, green	113.6	114.6
Shale, red	114.6	121.3
Shale, olive	121.3	124.0

Shale, medium greenish gray	124.0	145.0
Shale, medium gray	145.0	173.2
Zeandale Formation:		
Maple Hill Member:		
Limestone, dark gray, finely crystalline, contains brachiopods and fusulinids	173.2	174.4
Willard Formation:		
Shale, medium gray	174.4	176.3
Sandstone, medium gray, very limy	176.3	177.6
Shale, light greenish gray	177.6	191.0
Sandstone, light gray, contains black carbonaceous material	191.0	202.3
Shale, medium gray	202.3	218.8
Shale, medium gray, contains limy sandstone streaks throughout and limestone streaks near bottom	218.8	223.3
Shale, medium gray, interbedded with limestone, medium gray	223.3	225.0
Shale, olive	225.0	227.0
Shale, red mottled gray	227.0	231.4
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light grayish green, very finely crystalline, contains crinoids and glauconite	231.4	232.0
Limestone, very light gray, very finely crystalline, pseudo-oolitic, contains Osagia and pyrite	232.0	234.6
Shale, light greenish gray	234.6	235.1
Limestone, very light gray, very finely crystalline, pseudo-oolitic, contains brachiopods, crinoids, Osagia, and glauconite	235.1	240.3
Auburn Formation:		
Shale, green	240.3	240.8
Shale, red	240.8	251.3
Sandstone, light grayish green	251.3	258.5
Shale, medium gray	258.5	268.9
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains brachiopods and pyrite	268.9	272.3
Soldier Creek Formation:		
Shale, medium gray	272.3	273.0
Limestone, light greenish gray, lithographic, interbedded with shale, medium gray	273.0	275.0
Shale, green mottled red	275.0	277.4
Burlingame Formation:		
South Fork Member:		
Limestone, very light gray, very finely crystalline, contains Osagia	277.4	280.4
Winnebago Member:		
Shale, olive	280.4	281.4
Shale, medium gray	281.4	290.9
Taylor Branch Member:		
Limestone, light gray, finely crystalline, contains black carbonaceous material	290.9	295.7

Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, medium gray	295.7	296.7
Shale, black	296.7	298.7
Shale, medium gray	298.7	301.6
Limestone, medium gray, finely crystalline, contains fusulinids and pyrite, interbedded with shale, medium gray	301.6	303.0
Shale, black	303.0	303.2
Limestone, light grayish green, very finely crystalline, interbedded with shale, green	303.2	312.0
Shale, red	312.0	313.0
Shale, red, contains limestone streaks	313.0	317.0

Test Hole #9-81
Otoe County

Location: NW NE NW sec. 19, T. 8 N., R. 11 E., approximately 19 feet south of north section line and 1,775 feet east of west section line.
Ground elevation: 1,160.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, brown, sandy	3.0	4.5
Clay, medium gray to brown, sandy	4.5	6.0
Clay, light brown, very sandy	6.0	8.0
Clay, olive, sandy	8.0	10.0
Clay, tan, sandy	10.0	10.5
Permian System - Big Blue Series - Council Grove Group:		
Red Eagle Formation:		
Bennett Member:		
No sample	10.5	15.5
Glenrock Member:		
No sample	15.5	17.0
Johnson Formation:		
No sample	17.0	20.0
Limestone, olive to medium gray, very finely crystalline	20.0	21.0
Limestone, light gray, very finely crystalline	21.0	23.0
Shale, grayish green	23.0	23.5
Limestone, medium greenish gray, very finely crystalline	23.5	24.0
Limestone, gray to pale red, very finely crystalline	24.0	27.4
Shale, green	27.4	27.5
Shale, tan, limy	27.5	28.5
Foraker Formation:		
Long Creek Member:		
Limestone, tan, very finely crystalline	28.5	30.0
Limestone, medium gray, very finely crystalline	30.0	30.4
Limestone, tan, very finely crystalline	30.4	32.5
Limestone, medium gray, finely crystalline	32.5	34.0
Hughes Creek Member:		
Shale, dark gray, interbedded with limestone, medium gray	34.0	38.8
Limestone, medium gray, medium to finely crystalline, contains fusulinids, brachiopods, crinoids, and Osagia	38.8	41.1
Shale, light gray	41.1	41.8
Shale, medium gray, interbedded with limestone, medium gray	41.8	45.0
Shale, medium to dark gray	45.0	47.5
Limestone, light gray to medium gray, finely crystalline, contains brachiopods, fusulinids, and pyrite	47.5	48.4

Shale, light gray	48.4	50.0
Limestone, light gray, finely crystalline, contains brachiopods and crinoids, interbedded with shale, light gray	50.0	51.6
Shale, light gray	51.6	52.0
Shale, light grayish green	52.0	53.9
Limestone, medium gray, finely crystalline	53.9	55.1
Shale, very dark gray	55.1	56.8
Limestone, medium gray, finely crystalline, contains Osagia and "black inclusions"	56.8	58.4
Shale, medium gray	58.4	59.0
Limestone, dark gray, finely crystalline, contains Osagia	59.0	59.2
Shale, medium gray	59.2	60.7
Limestone, medium gray, finely crystalline	60.7	61.1
Shale, medium gray	61.1	61.6
Limestone, medium gray, medium crystalline, contains brachiopods, crinoids, fusulinids, and Osagia	61.6	63.3
Limestone, medium gray, finely crystalline, contains crinoids, fusulinids, brachiopods, and "black inclusions"	63.3	64.0
Limestone, light gray, finely crystalline, contains abundant crinoids, interbedded with shale, medium gray	64.0	64.5
Shale, medium to very dark gray	64.5	65.0
Limestone, medium gray, very finely crystalline	65.0	65.6
Shale, medium to dark gray	65.6	65.9
Limestone, medium gray, finely crystalline	65.9	67.1
Shale, medium greenish gray	67.1	68.1
Shale, medium gray	68.1	69.0
Limestone, medium gray, finely crystalline, contains brachiopods, Osagia, and "black inclusions"	69.0	71.4
Shale, medium gray	71.4	74.1
Shale, black	74.1	74.3
Americus Member:		
Limestone, medium gray, very finely crystalline, contains brachiopods, bryozoans, and black carbonaceous material	74.3	75.8
Shale, dark gray	75.8	76.8
Limestone, light gray, finely crystalline, contains crinoids, interbedded with shale, dark gray	76.8	77.0
Limestone, medium gray, finely crystalline, contains brachiopods and fusulinids	77.0	77.3
Shale, medium to dark gray	77.3	77.7
Limestone, light gray, very finely crystalline, contains brachiopods and crinoids	77.7	78.1
Admire Group:		
West Branch - Hamlin Formations:		
Shale, light gray	78.1	82.3
Limestone, medium gray, very finely crystalline	82.3	82.6
Shale, medium gray	82.6	88.1
Limestone, medium gray, very finely crystalline, contains pyrite	88.1	88.3

Shale, medium gray	88.3	88.9
Limestone, medium gray, finely crystalline, contains brachiopods, Osagia, and pyrite	88.9	90.1
Shale, green	90.1	92.0
Shale, reddish green	92.0	93.8
Shale, green	93.8	94.7
Limestone, cream, very finely crystalline	94.7	95.8
Shale, green	95.8	96.0
Shale, red	96.0	97.0
Shale, medium gray	97.0	97.4
Limestone, light gray, very finely crystalline	97.4	98.0
Shale, grayish green	98.0	98.4
Shale, red	98.4	99.0
Shale, olive	99.0	99.5
Shale, red mottled green	99.5	100.0
Shale, olive	100.0	100.3
Limestone, very light gray, very finely crystalline, contains glauconite	100.3	102.5
Shale, red, interbedded with limestone, gray	102.5	104.0
Shale, olive	104.0	106.2
Shale, red	106.2	108.2
Shale, green	108.2	109.0
Shale, olive	109.0	109.8
Shale, medium gray	109.8	111.0
Shale, green	111.0	112.1
Shale, light gray	112.1	113.8
Shale, dark green	113.8	114.5
Shale, green, interbedded with limestone, gray	114.5	115.8
Shale, red mottled green	115.8	116.9
Limestone, light greenish gray, very finely crystalline, contains glauconite	116.9	120.0

Test Hole #22-A-61
Otoe County

Location: SE NE SE sec. 24, T. 8 N., R. 11 E., approximately 1,888 feet north of south section line and 9 feet west of east section line.
Ground elevation: 1,159.3 ft. (Dunbar 7.5 min. quadrangle)
Depth to water: 15.37 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Till: clay, silty, sandy to gravelly, dark brown, yellowish brown and dark gray	0.5	0.9
Till: clay, silty, sandy to gravelly, dark brown, below 2.0 ft. principally yellowish brown, some iron stain, from 3.0 to 3.9 ft. slightly calcareous, below 8.0 ft. moderately to very calcareous.	0.9	13.7
Till: clay, silty, sandy to gravelly, very calcareous, olive yellow, below 15.0 ft. olive brown, some iron stain	13.7	23.1
Sand, medium to coarse, trace of fine gravel, some limy grains	23.1	25.2
Till: clay, silty, sandy to gravelly, very calcareous, dark brown, some iron stain, below 25.4 ft. yellowish brown	25.2	42.7
Gravel, sandy, coarse sand to coarse gravel	42.7	45.2
Till: clay, silty, sandy to gravelly, very calcareous, light gray to pale yellow	45.2	46.8
Sand, gravelly, medium sand to fine gravel, some reworked sandstone and limestone fragments	46.8	48.8
Till: clay, silty, sandy to gravelly, very calcareous, light gray to pale yellow	48.8	49.3
Sand, gravelly, medium sand to medium gravel	49.3	49.4
Till: clay, silty, sandy to gravelly, very calcareous, some iron staining	49.4	50.0
Sand, gravelly, medium sand to fine gravel	50.0	50.7
Till: clay, silty, sandy to gravelly, few pebbles, very calcareous, light gray to pale yellow	50.7	58.2
Sand, medium to coarse, few limy grains	58.2	59.5
Till: clay, silty, sandy to gravelly, very calcareous, light gray to light yellowish brown	59.5	60.0
Sand, medium to coarse, some very coarse, trace of gravel	60.0	61.5
Till: clay, silty, sandy to gravelly, very calcareous, light gray to light yellowish brown	61.5	65.6
Gravel, sandy, fine sand to coarse gravel, much reworked material	65.6	69.0
Till: clay, silty, sandy, gravelly, very calcareous, light gray to light yellow, below 70.0 ft. light grayish brown	69.0	71.1
Sand, fine to very coarse, trace of fine gravel, limy grains	71.1	75.0

Till: clay, silty, sandy, very calcareous, bluish gray, limy grains, below 75.2 ft. olive gray.....	75.0	83.9
Sandstone, very fine to fine grained.....	83.9	90.5
Sand, silty, very fine to fine, trace of medium, limy grains.....	90.5	94.8
Till: clay, silty, sandy, trace of gravel, moderately calcareous, bluish gray, limy grains.....	94.8	98.0
Sand, silty, very fine to medium, limy grains.....	98.0	99.5
Till: clay, silty, sandy to gravelly, very calcareous, olive brown, some sandstone fragments, below 100.0 ft. bluish gray.....	99.5	134.4
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Zeandale Formation:		
Sandstone, light gray, very fine grained, very finely micaceous, shaly.....	134.4	150.0
Shale, light greenish gray, sandy.....	150.0	160.0
Shale, medium gray.....	160.0	165.8
Limestone, medium bluish gray, finely crystalline, contains abundant brachiopod fragments, spines and crinoids.....	165.8	167.3
Shale, light greenish gray.....	167.3	171.4
Shale, medium gray.....	171.4	171.6
Limestone, light bluish gray, fine to very finely crystalline.....	171.6	172.1
Shale, light to medium greenish gray and limestone as above.....	172.1	173.0
Shale, light greenish gray.....	173.0	173.9
Limestone, light brown, very finely crystalline to dense, (poor sample).....	173.9	174.0

Test Hole #10-81
Otoe County

Location: NE corner SE sec. 30, T. 8 N., R. 11 E., approximately 2,463 feet north of south section line and 20 feet west of east section line.
Ground elevation: 1,136.5 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, tan, sandy	3.0	8.2
Sand, medium	8.2	8.5
Clay, tan, sandy	8.5	21.0
Clay, brown, sandy	21.0	26.0
Clay, tan	26.0	28.0
Clay, brown	28.0	32.0
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Hughes Creek Member:		
Shale, olive, interbedded with limestone, gray	32.0	34.3
Shale, olive gray, interbedded with limestone, gray	34.3	37.5
Limestone, medium gray, finely crystalline	37.5	37.9
Shale, olive	37.9	38.6
Limestone, tan, finely crystalline, contains brachiopods and "black inclusions"	38.6	39.0
Limestone, medium gray to tan, finely crystalline, contains brachiopods and "black inclusions"	39.0	40.1
Shale, olive, interbedded with limestone, gray	40.1	41.0
Shale, dark gray	41.0	42.4
Limestone, medium gray, finely crystalline, pseudo-oolitic, contains brachiopods	42.4	43.0
Shale, medium gray	43.0	43.1
Limestone, medium gray, finely crystalline, contains Osagia	43.1	44.8
Shale, medium gray	44.8	47.8
Shale, black	47.8	48.2
Americus Member:		
Limestone, medium to dark gray, very finely crystalline, contains fusulinids and brachiopods	48.2	49.2
Shale, dark gray	49.2	50.1
Limestone, medium gray, very finely crystalline, contains fusulinids and brachiopods	50.1	50.2
Shale, dark gray	50.2	50.7
Limestone, medium gray, very finely crystalline	50.7	51.3
Shale, dark gray	51.3	51.5
Limestone, medium gray, finely crystalline, contains brachiopods	51.5	52.0
Admire Group:		
Hamlin Formation:		
Oaks Member:		
Shale, medium gray	52.0	57.1

Limestone, medium gray, very finely crystalline, contains crinoids	57.1	57.8
Shale, medium gray	57.8	58.5
Limestone, medium gray, very finely crystalline, contains fusulinids	58.5	59.6
Shale, light green	59.6	62.0
Limestone, very light gray, lithographic, interbedded with shale, green	62.0	63.5
Shale, green to gray	63.5	65.0
Shale, red mottled green	65.0	66.8
Shale, green	66.8	67.5
Shale, dark gray	67.5	69.3
Houtchens Creek Member:		
Limestone, light gray, finely crystalline	69.3	70.1
Stine Member:		
Shale, olive gray	70.1	72.0
Shale, green	72.0	72.7
Limestone, medium gray, finely crystalline	72.7	73.8
Shale, red mottled green	73.8	74.7
Shale, light gray	74.7	75.9
Limestone, light greenish gray, finely crystalline, contains Osagia and abundant glauconite	75.9	77.2
Shale, medium olive gray	77.2	78.8
Shale, olive	78.8	79.8
Shale, medium gray	79.8	81.5
Shale, dark gray	81.5	85.0
Five Point Formation:		
Limestone, light gray, finely crystalline, contains crinoids, brachiopods, Osagia, and glauconite	85.0	86.2
West Branch Formation:		
Shale, light gray	86.2	88.1
Shale, green	88.1	89.3
Shale, reddish gray	89.3	91.0
Limestone, light gray, very finely crystalline	91.0	92.1
Shale, light green	92.1	93.4
Shale, light gray	93.4	100.0
Shale, black	100.0	100.5
Shale, light gray	100.5	102.1
Falls City Formation:		
Lehmer Member:		
Limestone, light gray, very finely crystalline	102.1	104.0
Limestone, medium gray, very finely crystalline, contains pyrite and "black inclusions"	104.0	107.0
Shale, light grayish green, interbedded with limestone, light gray	107.0	108.9
Reserve Member:		
Shale, medium gray	108.9	110.2
Miles Member:		
Limestone, medium gray, very finely crystalline	110.2	111.0
Onaga Formation:		
Shale, medium gray	111.0	111.4
Shale, green, interbedded with limestone, gray	111.4	112.0
Shale, light green	112.0	113.0
Shale, very light green	113.0	115.0

Shale, green	115.0	117.4
Shale, red	117.4	119.7
Shale, olive	119.7	119.9
Limestone, light greenish gray, very finely crystalline	119.9	120.7
Shale, red	120.7	124.5
Shale, light gray	124.5	127.7
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light gray, finely crystalline, contains Osagia	127.7	129.4
Shale, light gray	129.4	130.0

Test Hole #21-A-61
Otoe County

Location: SE corner SE sec. 36, T. 8 N., R. 11 E., approximately 7 feet north of south section line and 152 feet west of east section line.
Ground elevation: 1,113.2 ft. (Talmage 7.5 min. quadrangle)
Depth to water: 15.6 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.8
Clay, sandy to gravelly, dark brown, a few limy nodules, below 1.7 ft. brown	0.8	7.0
Gravel, sandy, coarse sand to medium gravel	7.0	10.0
Sand, gravelly, medium sand to fine gravel	10.0	15.8
Till: clay, silty, sandy to gravelly, very calcareous, light gray to yellowish brown, some limy areas, few pebbles, from 22.5 to 24.8 ft. light brownish gray	15.8	25.0
Till: clay, silty, sandy, moderately to very calcareous, light brownish gray, some limy nodules, below 39.5 ft. grayish brown, below 45.0 ft. few gravel grains	25.0	47.2
Till: clay, silty, sandy, very calcareous, bluish gray, some limy nodules, from 55.0 to 59.5 ft. few pebbles and gravel	47.2	58.0
Clay, silty, sandy, very calcareous, bluish gray, sand is very fine to coarse	58.0	63.0
Sand, silty, medium to coarse, some very coarse	63.0	67.0
Till: clay, silty, sandy to gravelly, very calcareous, bluish gray	67.0	75.4
Till: clay, silty, sandy, very calcareous, bluish gray, sand is very fine to medium	75.4	116.1
Clay, silty, sandy, olive brown, sand is very fine to fine, some pyrite nodes	116.1	118.5
Clay, silty, sandy, dark gray, sand is very fine to fine, below 118.5 ft. bluish gray	118.5	122.0
Silt, very sandy, light bluish gray, sand is very fine to medium	122.0	125.0
Sand, very silty, clayey, very fine to medium, limy grains	125.0	130.0
Sand, very fine to medium, some coarse, some limy grains	130.0	132.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Limestone, medium bluish gray, contains abundant Osagia, crinoids, brachiopods and spines	132.5	133.7
Shale, light greenish gray	133.7	140.4
Shale, medium gray	140.4	140.6
Shale, light greenish gray	140.6	141.4

Limestone, light bluish gray, finely crystalline to very finely crystalline and light greenish gray shale	141.4	143.0
Shale, light grayish green	143.0	144.0
Shale, dark reddish brown	144.0	145.5
Shale, dark reddish brown and light greenish gray	145.5	146.9
Limestone, light gray, finely crystalline, fossiliferous with much interbedded light greenish gray shale	146.9	148.0
Shale, dark reddish brown and pale yellow	148.0	149.9
Shale, light greenish gray	149.9	150.1
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light greenish gray, finely crystalline, shaly, contains crinoids	150.1	151.0
Limestone, light gray, fine to very finely crystalline, contains calcite stringers, brachiopod fragments and Osagia	151.0	153.5
Shale, light grayish green	153.5	154.6
Limestone, white, finely crystalline, chalky, contains calcite veins and shale, light greenish gray	154.6	156.5
Limestone, white to light gray, finely crystalline to granular, contains bryozoans and brachiopods	156.5	159.5
Auburn Formation:		
Shale, light greenish gray	159.5	160.5
Shale, dark reddish brown	160.5	161.7

Test Hole #2-A-66
Otoe County

Location: NW NW sec. 12, T. 8 N., R. 13 E., approximately 464 feet south of north section line and 10 feet east of west section line.
Ground elevation: 1,158.5 ft. (Nebraska City NW 7.5 min. quadrangle)
Depth to water: 23.36 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	1.0
Silt, moderately clayey, sandy, light yellowish brown, sand is very fine, in places some iron stain and gravel grains, from 5.2 to 5.7 ft. light brown, from 5.7 to 6.5 ft. light gray	1.0	11.5
Silt, very clayey, sandy, yellowish brown, sand is very fine to fine, some medium	11.5	12.1
Clay, silty, sandy, dark brown, sand is very fine to fine, some medium	12.1	13.7
Till: clay, silty, sandy, slightly calcareous, light yellowish brown, some limy areas, below 16.1 ft. pale brown	13.7	25.0
Till: silty, sandy, slightly calcareous, light yellowish brown, from 30.6 to 32.3 ft. grayish brown, below 34.0 ft. light olive brown	25.0	39.6
Boulder, quartzite	39.6	40.5
Till: clay, silty, sandy, moderately calcareous, pale brown, some iron stain	40.5	46.7
Sand, very fine to medium, some coarse	46.7	50.0
Sand, gravelly, very fine sand to coarse gravel	50.0	53.0
Sand, very fine to medium, below 55.0 ft. very fine to coarse	53.0	84.5
Silt, moderately clayey, brownish gray, below 86.5 ft. dark gray	84.5	92.0
Silt, clayey, sandy, medium gray, sand is very fine.	92.0	93.5
Silt, clayey, sandy, dark gray, sand is very fine, below 94.5 ft. brownish gray	93.5	96.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Stotler Formation:		
Dry Member:		
Sandstone, pale olive, very fine-grained, shaly	96.5	97.0
Shale, pale olive, very finely micaceous, sandy	97.0	106.0
Shale, light gray mottled with pale yellow, very finely micaceous	106.0	107.0
Shale, light gray and pale olive gray, very finely micaceous	107.0	111.0
Shale, light gray, clayey, sandy, very finely micaceous with some thin sandstone lenses, non-calcareous	111.0	115.0
Shale, light gray with some scattered pyrite	115.0	130.0
Shale, light gray, less sandy	130.0	140.9

Dover Member:		
Limestone, dark gray, finely crystalline, salt and pepper texture	140.9	141.4
Pillsbury Formation:		
Shale, light greenish gray, sandy	141.4	143.5
Sandstone, light greenish gray, lime cemented with thin light greenish gray shale seams	143.5	144.2
Sandstone, medium greenish gray, lime cemented, hard, very calcareous	144.2	145.0
Shale, light greenish gray, sandy with sandstone lenses as above	145.0	146.9
Shale, light greenish gray, moderately sandy, very slightly calcareous	146.9	147.5
Shale, light greenish gray, clayey, non-calcareous	147.5	150.9
Shale, medium gray, silty, non-calcareous with thin interbedded medium gray micaceous sandstone seams.	150.9	152.4
Sandstone, medium gray, micaceous, fine-grained, non-calcareous	152.4	152.8
Shale, medium gray, clayey, non-calcareous	152.8	158.5
Shale, medium gray, sandy, slightly to moderately calcareous	158.5	158.9
Zeandale Formation:		
Maple Hill Member:		
Limestone, medium to dark gray, finely crystalline, contains brachiopods and crinoids	158.9	159.5
Shale, medium gray with traces of coal	159.5	159.9
Coal, black	159.9	160.5

Test Hole #4-B-66
Otoe County

Location: NW corner sec. 25, T. 8 N., R. 13 E., approximately 136 feet south of north section line and 9 feet east of west section line.
Ground elevation: 1,197.5 ft. (Nebraska City NW 7.5 min. quadrangle)
Depth to water: 17.25 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	2.0
Silt, slightly clayey, slightly sandy, yellowish brown, sand is very fine to fine, from 2.5 to 3.3 ft. dark brown, below 3.3 ft. brown	2.0	5.0
Clay, silty, yellowish brown, some iron stain, below 6.7 ft. light brownish gray	5.0	8.0
Clay, silty, dark yellowish brown, some iron stain	8.0	8.3
Silt, moderately clayey, moderately sandy, yellowish brown, from 10.0 to 11.5 ft. dark yellowish brown.	8.3	13.5
Till: clay, silty, sandy, slightly gravelly, pale brown, some iron and manganese stain, from 30.0 to 37.7 ft. slightly calcareous, below 37.0 ft. moderately calcareous	13.5	42.0
Till: clay, silty, sandy, slightly calcareous, pale brown, cobble zone at 42.0 ft	42.0	48.0
Sand, very fine to medium, some coarse, few dark silicates, from 54.0 to 56.0 ft. silty	48.0	54.0
Till: clay, silty, sandy, slightly calcareous, yellowish brown, below 55.0 ft. yellowish brown	54.0	55.7
Till: clay, silty, gravelly, slightly calcareous, dark gray	55.7	85.0
Silt, clayey, sandy, slightly calcareous, gray, from 89.0 to 90.0 ft. olive gray, below 90.0 ft. grayish brown	85.0	90.0
Till: clay, silty, sandy, gravelly, slightly calcareous, grayish brown	90.0	90.5
Clay, silty, sandy, slightly calcareous, grayish brown, sand is very fine to fine, below 95.0 ft. dark gray	90.5	96.5
Silt, very clayey, moderately sandy, slightly calcareous, dark brown, sand is very fine to fine, below 99.0 ft. moderately clayey	96.5	101.0
Clay, silty, in part soil-like, grayish brown	101.0	101.3
Silt, moderately clayey, moderately sandy, slightly calcareous, grayish brown, sand is very fine to fine, some medium, below 103.6 ft. light yellowish brown	101.3	106.0
Sand, very fine to coarse, little very coarse	106.0	119.0

Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Stotler Formation:		
Dry Member:		
Shale, pale yellow, silty, moderately sandy, very slightly calcareous	119.0	120.0
Shale, pale red, silty, lightly sandy, contains limestone fragments	120.0	122.0
Shale, pale yellow, with medium reddish brown mottling, sandy and silty	122.0	122.5
Shale, pale yellow, silty, sandy, very slightly calcareous, very finely micaceous	122.5	123.0
Shale, pale yellow, sandy, very finely micaceous, non-calcareous	123.0	124.9
Shale, pale olive, very finely micaceous, silty, non-calcareous	124.9	125.3
Shale, pale olive, finely micaceous with some iron stain, non-calcareous	125.3	130.0
Shale, light olive brown, silty, non-calcareous	130.0	132.2
Shale, medium gray and light olive mottled, silty, non-calcareous	132.2	132.4
Shale, light gray, very finely micaceous, clayey, non-calcareous	132.4	138.5
Shale, medium gray and pale olive, clayey, very slightly calcareous	138.5	138.7
Shale, light to medium gray, clayey, non-calcareous.	138.7	140.0
Shale, pale olive, very sandy, very finely micaceous, contains thin sandstone seams, non-calcareous	140.0	142.5
Shale, medium olive mottled with brown, sandy, contains thin sandstone seams and black carbonaceous streaks, non-calcareous	142.5	146.2
Shale, light to medium gray, sandy, very finely micaceous, contains thin sandstone seams, black carbonaceous streaks and pyrite, non-calcareous...	146.2	160.0
Shale, light to medium gray, less sandy, moderately clayey, non-calcareous	160.0	165.0
Shale, light gray, clayey, non-calcareous	165.0	173.0
Dover Member:		
Limestone, dark gray, finely crystalline, salt and pepper texture	173.0	173.5
Pillsbury Formation:		
Shale, light greenish gray, sandy with thin dark greenish gray lime cemented sandstone seams, very calcareous	173.5	174.5
Sandstone, medium greenish gray, lime cemented, hard with interbedded thin light greenish gray shale seams, very calcareous	174.5	177.5
Shale, light greenish gray, slightly clayey with thin interbedded lime cemented sandstone seams....	177.5	178.8
Shale, medium gray, clayey, slightly calcareous.....	178.8	180.0

Test Hole #1-N-43
(A8-14-4bd1)
Otoe County

Location: SE NE NW sec 4, T. 8 N., R. 14 E., approximately 1,240 feet south and 2,350 feet east of northwest corner.
Ground elevation: 922.6 ft. (Nebraska City 7.5 min. quadrangle)
Depth to water: 8.0 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Sand, silty, brownish gray, texture of sand is very fine	0.0	2.0
Sand, brownish gray, texture grades from very fine to medium, contains some medium to coarse sand below 9.0 ft	2.0	15.0
Clay, bluish green	15.0	19.0
Sand, silty, light brown, texture of sand is very fine	19.0	25.0
Sand, pink and gray, texture grades from medium to coarse, contains some very coarse sand from 25.0 to 39.0 ft., and some fine gravel from 34.0 to 39.0 ft	25.0	44.0
Sand, texture grades from fine to medium with some coarse sand	44.0	49.0
Sand, texture grades from fine to very coarse, contains some fine gravel	49.0	54.0
Sand, texture grades from medium to coarse, contains many coal fragments below 60.0 ft	54.0	60.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Shale, clayey, medium greenish gray, contains some reddish brown silty to sandy shale below 65.0 ft., contains many coal fragments at 67.0 ft	60.5	67.3

Test Hole #2-N-43
(A8-14-4bd2)
Otoe County

Location: SE NE NW sec. 4, T. 8 N., R. 14 E., approximately 1,260 feet south and 2,600 feet east of northwest corner.
Ground elevation: 920.9 ft. (Nebraska City 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet	
	From	To
Quaternary System, undifferentiated:		
Sand, fine grained	0.0	2.0
Clay, silty to sandy, medium brownish gray, contains a trace of coarse sand to fine gravel grains below 8.0 ft	2.0	18.0
Sand, pink, texture grades from medium to coarse with a trace of fine gravel, contains some silty to sandy clay	18.0	23.0
Gravel and sand, texture grades from coarse sand to medium gravel	23.0	33.0
Sand, texture grades from fine to coarse, contains a trace of gravel	33.0	48.0
Sand, pink and dark silicates, texture grades from medium to coarse with some fine gravel	48.0	53.0
Clay, silty to sandy, medium to dark gray, contains sand to fine gravel	53.0	58.0
Sand, texture grades from medium to coarse with some fine gravel	58.0	63.0
Sand and gravel, texture grades from coarse sand to fine gravel, many dark silicates	63.0	68.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Clay or shale, silty, medium gray, may contain some sand from 68.0 to 70.0 ft	68.0	73.0
Shale, clayey, medium gray, slightly darker in color below 83.0 ft	73.0	87.0
Limestone, medium gray	87.0	88.0
Shale, clayey, light gray, contains some light gray limestone, in part greenish gray below 88.5 ft	88.0	90.0
Limestone, light gray to white	90.0	91.0

Test Hole #3-N-43
(A8-14-4bd3)
Otoe County

Location: SE NE NW sec 4, T. 8 N., R. 14 E., approximately 1,250 feet south and 2,450 feet east of northwest corner.
Ground elevation: 920.9 ft. (Nebraska City 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet	
	From	To
Quaternary System, undifferentiated:		
Sand, texture grades from very fine to fine.....	0.0	2.0
Clay, very silty, dark brownish gray.....	2.0	9.0
Silt, clayey to sandy, grading more sandy with depth	9.0	17.0
Sand, pink, texture grades from fine to coarse with some fine gravel.....	17.0	29.0
Gravel and sand, pink, texture grades from coarse sand to medium gravel, contains a few clay balls..	29.0	34.0
Sand, pink, texture grades from medium to coarse with a trace of fine gravel, contains slightly more fine gravel below 39.0 ft.....	34.0	52.0
Clay, sandy, bluish gray.....	52.0	54.0
Sand and gravel, pink with some dark grains, texture grades from sand to fine gravel, contains some clay or clay shale fragments.....	54.0	65.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Shale, clayey, red.....	65.0	69.0
Shale, clayey to silty, medium gray with a green tint, slightly darker color below 74.0 ft.....	69.0	90.5
Limestone, medium gray.....	90.5	91.5

Test Hole #6-A-61
Otoe County

Location: SE corner NE NE sec. 13, T. 9 N., R. 9 E., approximately 551 feet south of north section line and 10 feet west of east section line.
Ground elevation: 1,221.0 ft. (Elmwood 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Silt, moderately clayey, dark grayish brown, some iron stain, below 2.5 ft. light grayish brown	0.5	5.0
Silt, moderately sandy, slightly clayey, brown, sand is very fine to medium with some coarse, some iron stain, below 7.2 ft. few pebbles	5.0	11.0
Sand, slightly silty, very fine to medium with some coarse	11.0	24.0
Silt, very sandy, slightly clayey, grayish brown, sand is very fine to medium	24.0	28.0
Sand, fine to coarse, trace of very coarse	28.0	41.0
Silt, moderately sandy, slightly clayey, slightly calcareous, grayish brown, sand is very fine to medium	41.0	43.0
Sand, fine to medium, trace of coarse, from 43.5 to 43.6 ft. silt lens	43.0	48.0
Silt, moderately sandy, moderately clayey, slightly calcareous, olive gray, sand is very fine to coarse	48.0	50.0
Till: clay, silty, sandy, moderately calcareous, bluish gray, below 55.0 ft. sandy to gravelly	50.0	60.0
Silt, very sandy, slightly clayey, light bluish gray, sand is very fine to fine, trace of medium	60.0	64.0
Till: clay, silty, sandy to gravelly, slightly to in part moderately calcareous, bluish gray	64.0	86.5
Silt, very sandy, moderately clayey, slightly calcareous to 87.5 ft	86.5	90.0
Till: clay, silty, sandy, slightly calcareous to 93.0 ft., bluish gray, from 93.0 to 94.2 ft. dark gray	90.0	96.7
Till: clay, silty, sandy, slightly calcareous, gray	96.7	100.5
Gravel, principally reworked limestone grains	100.5	100.8
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Sandstone, fine grained, very finely micaceous, pale olive, contains limestone, brown, dense, 1 rhombopora (limonite stained)	100.8	101.5
Sandstone, as above, limonite stained	101.5	104.0

Sandstone, light gray, very fine grained, very finely micaceous	104.0	115.0
Shale, light gray, sandy	115.0	120.0
Shale, light to medium gray, contains fossils, brachiopods	120.0	128.7
Limestone, medium gray, finely crystalline, contains brachiopods	128.7	130.1
Shale, light greenish gray	130.1	132.3
Shale, pink and light greenish gray	132.3	133.5
Limestone, light brown, finely crystalline to dense, contains brachiopods and crinoids	133.5	134.0
Limestone, as above, mottled with pink	134.0	135.0
Shale, light reddish brown and light greenish gray	135.0	135.5
Shale, light greenish gray	135.5	136.2
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light gray, very finely crystalline, contains calcite string	136.2	138.9
Shale, light to medium gray	138.9	140.7
Limestone, white, very finely crystalline, chalky, contains glauconite and brachiopods	140.7	144.0

Test Hole #5-A-61
Otoe County

Location: SE corner SE sec. 25, T. 9 N., R. 9 E., approximately 194 feet north of south section line and 4 feet west of east section line.
Ground elevation: 1,190.9 ft. (Unadilla 7.5 min. quadrangle)
Depth to water: 35.35 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Clay, silty, dark gray, below 1.5 ft. dark grayish brown, below 2.0 ft. some iron stain	0.5	3.0
Silt, moderately clayey, brown, in part yellowish brown and brownish gray, some iron staining	3.0	16.0
Clay, silty, brown, some iron stain, below 23.0 ft. some yellowish brown	16.0	35.0
Silt, moderately clayey, moderately sandy, brown, sand is very fine to fine	35.0	39.0
Sand, very fine to very coarse, some fine gravel	39.0	42.0
Clay, silty, brown	42.0	46.0
Silt, moderately sandy, brown, sand is very fine to fine, below 50.2 ft. sand is very fine to medium	46.0	54.0
Sand, very silty, very fine to medium, some coarse to very coarse	54.0	58.0
Clay, silty, yellowish brown	58.0	61.0
Sand, very silty, very fine to coarse, some very coarse sand to fine gravel	61.0	64.0
Silt, moderately clayey, slightly calcareous, gray, some limy areas	64.0	85.0
Silt, very sandy, slightly clayey, slightly calcareous, gray, sand is very fine to medium, in places some limy grains	85.0	90.6
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, light greenish gray, contains limestone, brown, finely crystalline, (limonite stained)	90.6	90.8
Limestone, light gray, finely crystalline, contains pelecypods, limonite stained	90.8	91.0
Sandstone, light greenish gray,m very finely micaceous, shaly	91.0	95.8
Sandstone, as above, iron stained	95.8	100.0
Sandstone, as above with interbedded dark yellowish orange shale	100.0	100.5
Sandstone, light gray, very fine grained with black carbonaceous streaks	100.5	101.5
Sandstone, light gray, very fine grained, shaly, contains black carbonaceous streaks	101.5	110.0
Shale, light gray, very finely micaceous, slightly sandy	110.0	120.0
Shale, light to medium gray	120.0	124.4

Limestone, medium gray, very finely crystalline, contains fossil fragments with interbedded dark gray shale	124.4	128.0
Shale, light greenish gray	128.0	128.5
Limestone, light greenish gray, shaly, finely crystalline	128.5	129.1
Shale, pink and light greenish gray	129.1	130.4
Limestone, brown, dense with interbedded medium grayish green shale	130.4	130.8
Limestone, as above mottled with pink	130.8	132.5
Shale, light reddish brown and light greenish gray	132.5	134.4
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light gray, fine to very finely crystalline, shaly	134.4	134.6
Limestone, light brown, fine crystalline, contains brachiopods	134.6	136.4
Shale, light to medium gray	136.4	137.9
Limestone, white, very finely crystalline, chalky, contains glauconite	137.9	143.4
Shale, light greenish gray	143.4	144.5
Limestone, light gray,m very finely crystalline, contains shale, dark reddish brown	144.5	145.2
Auburn Formation:		
Shale, dark reddish brown	145.2	149.0
Sandstone, light gray, very fine grained, very finely micaceous, shaly, (stained red)	149.0	154.8
Sandstone, as above with limestone, dark bluish gray, finely crystalline	154.8	155.2
Shale, medium olive, sandy	155.2	156.5
Shale, light gray, very finely micaceous, sandy	156.5	160.0
Shale, medium to dark gray	160.0	167.8
Wakarusa Formation:		
Limestone, medium bluish gray, very finely crystalline, contains spines and fossil fragments, (brachiopods)	167.8	169.2
Shale, light to medium gray	169.2	169.6
Limestone, medium bluish gray, very finely crystalline, contains crinoids	169.6	170.0

Test Hole #15-A-56
Otoe County

Location: C EL NE SE sec. 1, T. 9 N., R. 11 E., approximately 1780 feet north and 5 feet west of southeast corner.
Ground elevation: 1,181.1 ft. (Avoca 7.5 min. quadrangle)
Depth to water: 17.55 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	1.7
Silt, very clayey, dark brownish gray	1.7	3.2
Soil: silt, slightly clayey, dark brownish gray	3.2	4.0
Silt, moderately clayey, dark brownish gray to yellowish gray, below 18.5 ft. slightly sandy	4.0	22.0
Silt, moderately sandy, slightly clayey, brownish gray, sand is very fine to fine	22.0	24.0
Clay, silty, slightly sandy, yellowish gray, sand is very fine	24.0	27.0
Silt, very clayey, slightly sandy, brownish gray, below 29.0 ft. moderately clayey	27.0	35.0
Silt, slightly clayey, sandy, light gray, sand is very fine, below 46.5 ft. medium gray, in places limy areas	35.0	62.1
Silt, slightly clayey, dark gray, from 64.4 to 64.5 ft. light gray, below 64.5 ft. dark gray to black.	62.1	67.1
Silt, moderately clayey, gray, below 75.0 ft. in part slightly sandy, sand is very fine	67.1	92.0
Silt, slightly clayey, sandy, brownish gray, sand is very fine to fine, below 108.0 ft. medium gray	92.0	112.0
Pennsylvanian System - Virgil Series - Shawnee Group:		
Tecumseh Formation:		
Oskaloosa - Rakes Creek Members:		
Shale, light medium gray, sandy to sandstone, poorly consolidated, contains light gray shale from 112.0 to 112.1 ft	112.0	113.0
Shale, light medium gray, slightly sandy, contains very fine sand, more limy from 114.5 ft	113.0	115.0
Sandstone, light medium gray, shaly, very fine grained, moderately cemented, contains few thin silt layers	115.0	120.0
Sandstone, as above with light gray shale	120.0	135.0
Shale, light gray	135.0	137.0
Shale, light medium gray with red tint, in part limy, argillaceous, sandy	137.0	138.0
Shale, dark reddish brown	138.0	141.5
Ost Member:		
Limestone, light gray, dense	141.5	144.0
Kenosha Member:		
Shale, medium reddish gray, clayey	144.0	145.4
Lecompton Formation:		
Avoca Member:		
Limestone, light gray, dense	145.4	147.8
King Hill Member:		

Shale, light gray to medium gray with red tint, clayey, in part with limy layers.....	147.8	150.0

Test Hole #1-O-38
(A9-11-13da)
Otoe County

Location: NE SE sec. 13, T. 9 N., R. 11 E., approximately 1,900 feet north and 580 feet west of southeast corner.
Ground elevation: 1,190.0 ft. (Dunbar 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil and till	0.0	5.0
Till	5.0	33.0
Silt or fine sand, (no sample obtained), hard limy layer from 33.0 to 33.3 ft	33.0	59.5
Pennsylvanian System - Virgil Series - Shawnee Group:		
Topeka Formation:		
Curzon Member:		
Limestone, pale yellow to light tan, fine to irregular crystalline, contains fusulinids, crinoids, brachiopods, chert, light gray	59.5	60.5
Iowa Point Member:		
Shale, pale yellow to buff	60.5	63.5
Hartford Member:		
Limestone, dark yellowish orange, finely crystalline, (manganese dendrites) stained red in part	63.5	64.8
Calhoun Formation:		
Shale, pale olive	64.8	66.3
Deer Creek Formation:		
Ervine Creek Member:		
Limestone, pale yellow to dark yellowish orange, oolitic in part, crystalline and light gray finely crystalline, contains (fusulinids and crinoids)	66.3	67.3
Shale, pale yellow	67.3	68.0
Limestone, pale yellow, finely crystalline	68.0	68.1
Shale, pale yellow with two very thin limestone seams	68.1	69.1
Limestone, pale yellow, finely crystalline, contains brachiopods, crinoids and fusulinids	69.1	70.8
Shale, pale yellow	70.8	72.8
Limestone, pale yellow, fine to irregularly crystalline, contains fusulinids, crinoids, spines, brachiopods and chert, tan	72.8	81.8
Shale, blue, soft	81.8	83.1
Limestone, light gray, finely crystalline	83.1	83.9
Larsh Member:		
Shale, medium to dark gray and black, fissile	83.9	86.2

Test Hole #12-81
Otoe County

Location: SW corner sec. 13, T. 9 N., R. 11 E., approximately 212 feet north of south section line and 22 feet east of west section line.
Ground elevation: 1,132.5 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	8.0
Clay, tan, very sandy	8.0	14.5
Sand, medium to coarse	14.5	15.0
Clay, tan, sandy	15.0	16.0
Clay, medium gray, sandy	16.0	17.0
Pennsylvanian System - Virgil Series - Shawnee Group:		
Topeka Formation:		
Curzon Member:		
No sample	17.0	22.0
Iowa Point Member:		
Shale, light gray	22.0	22.6
Hartford Member:		
Limestone, tan to light gray, very finely crystalline, contains Osagia and manganese staining	22.6	23.0
Shale, black	23.0	23.1
Limestone, medium gray, finely crystalline	23.1	24.2
Calhoun Formation:		
Shale, medium gray	24.2	25.0
Tecumseh - Deer Creek Formations:		
Ervine Creek Member:		
Limestone, light bluish gray, medium to coarsely crystalline, contains crinoids, brachiopods, and Osagia	25.0	28.0
Limestone, light bluish gray, finely crystalline, contains Osagia and glauconite	28.0	30.1
Limestone, light gray, very finely crystalline, contains Osagia and fusulinids	30.1	32.2
Limestone, medium to dark gray, finely crystalline, contains pyrite, abundant fusulinids, and abundant black carbonaceous material	32.2	34.0
Limestone, dark gray, finely crystalline, contains pyrite, black carbonaceous material, and fusulinids	34.0	36.3
Shale, black	36.3	36.4
Limestone, medium gray, finely crystalline, contains Osagia and abundant fusulinids	36.4	38.6
Shale, medium gray	38.6	39.5
Limestone, light gray, finely crystalline, contains crinoids, fusulinids, pyrite, and Osagia	39.5	40.4
Larsh Member:		
Shale, medium gray	40.4	41.0
Shale, black	41.0	42.4

Rock Bluff Member:		
Limestone, light gray to tan, very finely crystalline, contains Osagia and pyrite	42.4	44.3
Oskaloosa - Rakes Creek Members:		
Shale, medium gray	44.3	45.2
Shale, medium greenish gray	45.2	47.6
Siltstone, light greenish gray, sandy	47.6	55.0
Shale, green	55.0	69.5
Shale, red	69.5	72.9
Ost Member:		
Limestone, light gray, very finely crystalline, silty, contains Osagia	72.9	75.8
Limestone, very light grayish green to white, very finely crystalline to lithographic, contains Osagia and glauconite	75.8	79.1
Kenosha Member:		
Shale, red mottled green	79.1	80.8
Lecompton Formation:		
Avoca Member:		
Limestone, light gray, very finely crystalline, contains Osagia and brachiopods	80.8	81.2
Limestone, light to medium gray, finely crystalline, pseudo-oolitic in part, contains crinoids and Osagia	81.2	82.7
King Hill Member:		
Shale, red	82.7	87.5
Shale, medium greenish gray	87.5	89.6
Beil Member:		
Limestone, very light gray to white, very finely crystalline, contains pyrite, glauconite, coral, and Osagia	89.6	92.0

Test Hole #13-81
Otoe County

Location: SW corner sec. 24, T. 9 N., R. 11 E., approximately 85 feet north of south section line and 73 feet east of west section line.
Ground elevation: 1,148.5 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	6.0
Clay, medium gray, sandy	6.0	14.0
Clay, tan, sandy	14.0	25.0
Clay, olive gray, sandy	25.0	32.0
No sample	32.0	40.0
Clay, medium gray, sandy, silty	40.0	49.0
Clay, medium gray, silty, very sandy	49.0	55.0
Clay, medium gray, sandy, silty	55.0	100.5
Sand, coarse, contains gravel	100.5	107.0
Clay, medium gray, sandy	107.0	111.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, medium gray	111.5	120.0
Coal, black	120.0	120.2
Shale, medium gray	120.2	137.0
Shale, medium gray, contains brown sandstone streaks	137.0	162.9
Howard Formation:		
Limestone, dark gray, finely crystalline, contains crinoids	162.9	163.3
Shale, medium greenish gray	163.3	164.4
Limestone, dark gray, finely crystalline, contains brachiopods, pyrite, and "black inclusions"	164.4	165.0
Shale, light greenish gray	165.0	168.1
Limestone, medium gray, finely crystalline, contains Osagia, coral, brachiopods, pyrite, "black inclusions", and abundant fusulinids	168.1	170.0
Limestone, light gray, very finely crystalline, contains Osagia and pyrite	170.0	171.7
Severy Formation:		
Shale, light gray	171.7	172.2
Shale, black	172.2	173.0
Shale, medium grayish green	173.0	176.0
Coal, black	176.0	177.0
Shale, medium grayish green	177.0	183.0
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray, finely crystalline, contains pyrite	183.0	185.0
Shale, medium gray	185.0	185.8

Limestone, medium gray, very finely crystalline, contains brachiopods, coral, and pyrite.....	185.8	187.2
Shale, medium gray.....	187.2	188.0
Limestone, medium to dark gray, very finely crystalline, contains fusulinids, crinoids, and pyrite...	188.0	189.6
Limestone, light gray, finely crystalline, contains fusulinids, crinoids, pyrite and abundant brachiopods.....	189.6	190.0
Holt Member:		
Shale, medium gray.....	190.0	191.0
Shale, black.....	191.0	192.1
Du Bois Member:		
Limestone, light to very dark gray, finely crystalline, contains brachiopods, pyrite, "black inclusions", and abundant crinoids.....	192.1	193.4
Turner Creek Member:		
Shale, medium greenish gray.....	193.4	196.1
Sheldon Member:		
Limestone, light to medium gray, very finely crystalline, pseudo-oolitic in part, contains crinoids, pyrite, and abundant fusulinids.....	196.1	197.0

Test Hole #24-A-61
Otoe County

Location: SE SE SE sec. 25, T. 9 N., R. 11 E., approximately 5 feet north of south section line and 224 feet west of east section line.
Ground elevation: 1,214.6 ft. (Dunbar 7.5 min. quadrangle)
Depth to water: 8.35 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Clay, silty, sandy, brown, sand is very fine, some iron stain, below 1.3 ft. mottled brown to light gray	0.5	1.6
Silt, slightly clayey, sandy, light brownish gray, sand is very fine, some iron stain, below 3.0 ft. grayish brown	1.6	4.0
Silt, very clayey, granular, brown, some iron stain.	4.0	8.0
Clay, silty, brown, below 10.0 ft. dark staining	8.0	10.5
Till: clay, silty, sandy to gravelly, yellowish brown, below 15.0 ft. very calcareous, pale yellow	10.5	20.5
Till: clay, silty, sandy to gravelly, very calcareous, light brownish gray, some iron stain, few pebbles, below 25.0 ft. some light gray	20.5	35.0
Till: clay, silty, sandy to gravelly, very calcareous, light gray to pale yellow, from 35.0 to 36.0 ft. few pebbles, from 37.4 to 40.0 ft. light yellowish brown	35.0	43.4
Till: silt, sandy, very calcareous, pink, from 44.0 to 45.0 ft. brownish yellow, from 45.0 to 46.1 ft. yellowish brown, below 46.1 ft. light gray to brownish yellow	43.4	47.5
Till: clay, silty, sandy to gravelly, very calcareous, yellowish brown to light gray, from 50.7 to 51.4 ft. boulder, below 51.4 ft. yellowish brown	47.5	54.0
Till: clay, silty, sandy to gravelly, very calcareous, dark bluish gray	54.0	58.6
Sand, gravelly, silty, clayey, very fine sand to coarse gravel	58.6	60.0
Till: clay, silty, sandy to gravelly, very calcareous, olive gray, from 62.9 to 64.9 ft. some bluish gray	60.0	69.0
Silt, very sandy, slightly clayey, very calcareous, olive, sand is very fine to medium	69.0	69.6
Till: clay, silty, sandy to gravelly, very calcareous, bluish gray	69.6	71.4
Gravel, sandy, clayey, silty, fine sand to coarse gravel	71.4	73.1
Sand, very silty, slightly clayey, very fine to coarse sand, some medium grains	73.1	74.9

Till: clay, silty, sandy to gravelly, very calcareous, bluish gray, from 79.6 to 80.0 ft. shale, varigated	74.9	82.9
Sand, medium grained	82.9	84.8
Shale, clayey, moderately calcareous, varigated	84.8	85.9
Silt, moderately clayey, sandy, slightly calcareous, dark bluish gray, sand is very fine	85.9	88.5
Till: clay, silty, sandy to gravelly, very calcareous, dark bluish gray	88.5	95.0
Silt, very clayey, sandy, very dark gray, sand is very fine, below 98.3 ft. light bluish gray, below 100.4 ft. very calcareous	95.0	103.7
Till: clay, silty, sandy to gravelly, very calcareous, light bluish gray, below 107.9 ft. some limestone pebbles	103.7	110.0
Permian System - Big Blue Series - Admire Group:		
West Branch Formation:		
Shale, light greenish gray and pale olive, very calcareous	110.0	119.0
Shale, light greenish gray and pale yellow, limonite stained in part	119.0	120.9
Falls City Formation:		
Lehmer Member:		
Limestone, medium yellow with some light greenish gray	120.9	124.1
Reserve Member:		
Shale, pale yellow with some light gray	124.1	124.5
Shale, light to medium gray	124.5	125.3
Shale, light gray	125.3	126.0
Shale, medium gray	126.0	126.7
Shale, dark gray and black carbonaceous	126.7	127.3
Shale, dark gray and dark olive	127.3	127.4
Miles Member:		
Limestone, medium bluish gray, fine to very finely crystalline, contains "black inclusions" and some shale	127.4	129.1
Onaga Formation:		
Shale, pale yellow and light gray	129.1	129.3
Shale, light greenish gray, nodular	129.3	129.7
Shale, dark yellowish brown and light greenish gray	129.7	131.0
Shale, pale olive	131.0	132.8
Shale, light grayish green	132.8	135.0
Shale, dark reddish brown	135.0	136.0
Shale, light greenish gray and dark reddish brown mottled	136.0	144.6
Shale, dark greenish gray	144.6	145.6
Shale, light greenish gray and dark reddish brown mottled	145.6	146.0
Shale, pale olive	146.0	146.7

Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light greenish gray, finely crystalline, contains pelecypods and brachiopods, and limestone, light gray stained red and green, finely crystalline, contains fossils, abundant brachiopods	146.7	147.5
Shale, pale olive	147.5	147.8
Limestone, light greenish gray, finely crystalline, contains spines and interbedded shale	147.8	148.0
Pony Creek - Plumb Members:		
Shale, light grayish green	148.0	149.6
Shale, dark reddish brown	149.6	161.0
Shale, light greenish gray, dark reddish brown, light gray and pale yellow	161.0	162.1
Shale, dark gray, very finely micaceous, sandy	162.1	163.7
Nebraska City Member:		
Limestone, light bluish gray, finely crystalline, contains abundant pyrite and glauconite	163.7	164.0
Root Formation:		
French Creek Member:		
Shale, light greenish gray, contains brachiopod fragments and pyrite	164.0	164.3
Shale, black "coal" (Lorton)	164.3	165.5
Shale, light grayish green, contains brachiopods and crinoids	165.5	170.7

Test Hole #11-81
Otoe County

Location: SW corner sec. 25, T. 9 N., R. 11 E., approximately 205 feet north of south section line and 21 feet east of west section line.
Ground elevation: 1,239.0 ft. (Syracuse 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, tan, silty	3.0	5.0
Clay, tan, silty, sandy	5.0	12.0
Clay, red, sandy	12.0	17.5
Clay, tan, sandy	17.5	25.5
Clay, light greenish gray	25.5	32.0
Clay, medium gray, very sandy	32.0	37.0
Clay, gray to brown, sandy	37.0	45.0
Clay, light grayish green to brown, sandy	45.0	47.5
Clay, gray to olive brown, sandy	47.5	55.0
Clay, olive, sandy	55.0	70.4
Sand, very fine	70.4	77.0
Sand, fine	77.0	107.0
Sand, very fine	107.0	115.5
Sand, fine	115.5	131.0
Sand, fine, very silty	131.0	137.5
Clay, medium gray, sandy, silty	137.5	173.0
Clay, medium gray	173.0	182.0
Sand, coarse	182.0	185.0
Sand, coarse, contains gravel	185.0	195.2
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Limestone, medium to dark gray, finely crystalline	195.2	197.0
Shale, light gray	197.0	200.6
Shale, medium gray	200.6	201.1
Shale, light greenish gray	201.0	203.0
Shale, dark red	203.0	204.4
Shale, grayish green	204.0	205.4
Emporia Formation:		
Elmont - Reading Members:		
Limestone, light gray to pale red, very finely crystalline, contains crinoids	205.4	208.3
Shale, olive	208.3	209.6
Limestone, light gray to tan, very finely crystalline, contains Osagia	209.6	211.0
Shale, light gray	211.0	211.8
Limestone, very light gray, very finely crystalline, pseudo-oolitic, contains brachiopods, crinoids, Osagia, and glauconite	211.8	214.4
Limestone, light gray, finely crystalline, contains crinoids, bryozoans, and Osagia	214.4	215.5

Auburn Formation:		
Shale, light grayish green mottled red	215.5	218.0
Shale, red	218.0	234.0
Shale, olive	234.0	235.6
Shale, medium gray	235.6	239.8
Sandstone, tan	239.8	240.0
Shale, medium gray	240.0	248.1
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains crinoids	248.1	248.9
Shale, medium gray	248.9	252.1
Shale, black	252.1	252.2
Limestone, medium gray, finely crystalline, contains brachiopods, pyrite, and "black inclusions"	252.2	253.0
Soldier Creek Formation:		
Shale, light gray	253.0	257.0
Shale, red	257.0	258.9
Shale, medium gray	258.9	259.3
Burlingame Formation:		
South Fork Member:		
Limestone, very light gray, finely crystalline, contains Osagia and glauconite	259.3	261.6
Winnebago Member:		
Shale, light grayish green	261.6	262.4
Shale, red	262.4	266.0
Shale, light gray	266.0	275.3
Taylor Branch Member:		
Limestone, medium to dark gray, finely crystalline, pseudo-oolitic, contains brachiopods and Osagia	275.3	277.0
Shale, medium gray	277.0	278.2
Limestone, medium gray, finely crystalline, pseudo-oolitic, contains fusulinids and Osagia	278.2	279.3
Scranton Formation:		
Silver Lake - White Cloud Members:		
Shale, green	279.3	280.3
Shale, light gray	280.3	284.8
Shale, black	284.8	286.5
Shale, light greenish gray	286.5	287.0
Shale, green	287.0	295.5
Shale, red mottled green	295.5	299.0
Shale, red mottled green, interbedded with limestone, medium gray	299.0	302.0

Test Hole #36-79
Otoe County

Location: NE corner sec. 12, T. 9 N., R. 12 E., approximately 27 feet south of north section and 175 feet west of east section line.
Ground elevation: 1,030.0 ft. (Avoca 7.5 min. quadrangle)
Depth to eater: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil, dark gray, silty, clayey	0.0	7.0
Clay, tannish gray, silty	7.0	14.0
Silt, tannish gray, sandy	14.0	22.0
Sand, medium to coarse, and gravel, very fine to coarse, contains limestone and granitic fragments.	22.0	31.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
White Cloud Member:		
Shale, light gray	31.0	35.0
Shale, medium gray	35.0	45.0
Howard Formation:		
Limestone, medium gray, finely crystalline, shaly, contains brachiopods	45.0	47.0
Limestone, tan, very finely to finely crystalline, highly weathered in part, contains pseudo-oolites, Osagia, and brachiopods	47.0	49.7
Severy Formation:		
Shale, medium gray	49.7	49.9
Shale, black	49.9	50.1
Shale, medium gray	50.1	52.0
Shale, black	52.0	52.7
Shale, medium gray	52.7	58.5
Coal, black	58.5	59.4
Shale, medium gray	59.4	62.3
Limestone, dark gray, very finely to finely crystalline, contains crinoids	62.3	63.0
Shale, medium gray	63.0	64.3
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray to tannish gray, very finely crystalline, contains brachiopods	64.3	66.5
Shale, dark gray	66.5	67.4
Limestone, dark tannish gray, very finely to finely crystalline, contains crinoids and fusulinids	67.4	68.1
Shale, light gray, limy	68.1	68.4
Limestone, light to medium gray, finely crystalline, contains crinoids	68.4	69.2
Holt Member:		
Shale, dark gray	69.2	69.5
Shale, black	69.5	71.0

DuBois Member:		
Limestone, dark gray, finely crystalline, contains crinoids and pyrite	71.0	71.6
Turner Creek Member:		
Shale, medium gray, contains hard limy zones	71.6	72.0
Limestone, light gray to light greenish gray, finely crystalline, shaly, contains brachiopods and crinoids	72.0	73.6
Shale, light greenish gray	73.6	75.3
Shale, olive with greenish gray interbedded	75.3	75.5
Sheldon Member:		
Limestone, very light tan to cream, very finely crystalline, pseudo-oolitic, contains brachiopods and abundant Osagia	75.5	78.5
Limestone, very light tan to cream, very finely crystalline, pseudo-oolitic, contains brachiopods, crinoids, and abundant Osagia, interbedded with shale, olive	78.5	79.0
Jones Point Member:		
Shale, light olive gray	79.0	80.7
Limestone, very light gray, finely crystalline, contains crinoids	80.7	82.2
Shale, light to medium gray	82.2	83.0
Curzon Member:		
Limestone, pale olive yellow, very finely crystalline	83.0	86.0
Limestone, pale olive yellow with orange tint, very finely to finely crystalline, contains crinoids	86.0	86.4
Limestone, light olive gray, very finely crystalline, contains crinoids, fusulinids and ostracods.	86.4	87.6
Iowa Point Member:		
Shale, dark gray with medium gray interbedded	87.6	88.4
Hartford Member:		
Limestone, light to medium tannish gray, very finely crystalline, contains algal material	88.4	89.5
Calhoun Formation:		
Shale, medium gray, limy	89.5	90.2
Deer Creek Formation:		
Ervine Creek Member:		
Limestone, very light gray, finely crystalline, contains pelecypods and fusulinids	90.2	92.5
Limestone, light olive yellow, very finely to finely crystalline, contains crinoids, bryozoans, and algal material	92.5	95.0
Limestone, light gray, finely crystalline, contains crinoids, fusulinids, and Osagia	95.0	95.5

Limestone, light gray, finely crystalline, contains pyrite and ostracods, interbedded with shale, light gray.....	95.5	95.7
Limestone, light to medium gray, finely crystalline, contains crinoids and pyrite.....	95.7	96.8
Limestone, tannish gray, very finely crystalline, contains brachiopods.....	96.8	99.0
Limestone, dark tannish gray, very finely to finely crystalline, contains crinoids, fusulinids, and chert.....	99.0	106.5
Shale, medium gray.....	106.5	107.0

Test Hole #2-B-39
Otoe County

Location: NE NE sec. 31, T. 9 N., R. 12 E., approximately 150 feet south and 400 feet west of northeast corner.
Ground elevation: 1,101.0 ft. (Dunbar 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Silt, in part clayey, dark brownish gray.....	0.0	16.0
Silt, light brownish gray.....	16.0	20.0
Silt, in part clayey, light brownish gray and medium gray.....	20.0	40.0
Silt, clayey, light gray, contains a little sand....	40.0	44.0
Sand and gravel, contains some reworked shale, limestone and chert, principally reworked shale below 51.0 ft.....	44.0	56.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Shale, bluish gray, contains a trace of limestone cuttings in intervals from 51.0 to 60.0 ft., and from 65.0 to 70.0 ft.....	56.0	76.1
Sandstone, shaly and micaceous, bluish gray.....	76.1	83.8
Limestone, in part sandy.....	83.8	84.1
Shale, micaceous, bluish gray to greenish gray, thin sandstone layer at 88.0 ft.....	84.1	100.0
Shale, gray.....	100.0	115.2
Limestone, bluish gray, contains some fossil fragments.....	115.2	117.7
Shale, bluish gray, contains a trace of limestone in lower part.....	117.7	122.0
Limestone, light gray, crystalline.....	122.0	123.2
Shale, bluish to greenish gray, brownish maroon below 124.5 ft.....	123.2	125.5
Limestone, gray with mottled pink.....	125.5	126.2
Shale, maroon and greenish gray.....	126.2	126.6
Limestone, light gray and greenish gray, crystalline	126.6	127.5
Shale, greenish gray with a little maroon, contains some white limy areas.....	127.5	129.8
Shale with some limestone, greenish to bluish gray..	129.8	130.6
Shale, greenish to bluish gray, grades to very fine-grained sand.....	130.6	134.7
Sandstone, gray, friable, micaceous.....	134.7	136.8
Shale, silty, bluish gray, contains a trace of fine-grained sand.....	136.8	145.0
Shale, argillaceous to silty, bluish to brownish gray, bluish gray below 155.0 ft.....	145.0	156.8
Sandstone and calcareous mudstone, gray.....	156.8	157.5
Mudstone to limestone, bluish gray, argillaceous below 160.3 ft.....	157.5	161.0
Shale, bluish gray to dark gray, argillaceous to finely micaceous.....	161.0	164.0

Test Hole #13-79
Otoe County

Location: NE corner NW sec. 4, T. 9 N., R. 13 E., approximately 28 feet south of north section line and 2,475 feet east of west section line.
Ground elevation: 998.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil, dark gray, contains organic material.....	0.0	6.0
Clay, dark brown, silty.....	6.0	16.0
Silt, light gray, clayey, sandy.....	16.0	22.0
Sand very fine to coarse.....	22.0	71.0
Clay, light brown, silty, sandy.....	71.0	77.0
Sand, very fine to fine, silty.....	77.0	85.0
Silt, light gray, sandy.....	85.0	92.0
Sand, very fine to fine, silty.....	92.0	100.0
Silt, gray, clayey.....	100.0	103.2
Gravel, very fine to medium.....	103.2	107.0
Silt, gray.....	107.0	110.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Cedarvale - White Cloud Members:		
Shale, light to medium gray.....	110.0	129.0
Howard Formation:		
Limestone, dark tannish gray, very finely crystalline, contains brachiopods, pyrite and "black inclusions".....	129.0	133.0
Severy Formation:		
Shale, black, contains carbonaceous material.....	133.0	135.0
Shale, light gray.....	135.0	141.5
Shale, black, contains carbonaceous material.....	141.5	142.1
Shale, medium gray.....	142.1	144.5
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray, very finely crystalline, contains brachiopods.....	144.5	149.3
Shale, light gray.....	149.3	150.0
Limestone, medium to dark gray, very finely crystalline, contains brachiopods and crinoids.....	150.0	150.5
Shale, medium to dark gray.....	150.5	151.0
Limestone, medium to dark gray, very finely crystalline, contains brachiopods.....	151.0	151.5
Shale, medium to dark gray.....	151.5	152.0

Test Hole #6-79
Otoe County

Location: SW SW SW SE sec. 5, T. 9 N., R. 13 E., approximately 18 feet north of south section line and 21 feet east of half section line.
Ground elevation: 1,104.5 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	2.0
Silt, light brown, clayey	2.0	30.0
Sand, very fine to medium, silty	30.0	40.0
Clay, light brownish gray, silty	40.0	47.0
Silt, dark brown, sandy	47.0	50.0
Sand, very fine to medium	50.0	107.0
Sand, very fine to coarse	107.0	127.3
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Cedarvale - White Cloud Members:		
Shale, greenish blue	127.3	129.0
Shale, reddish brown	129.0	131.0
Shale, olive	131.0	132.0
Shale, reddish brown	132.0	134.7
Shale, medium gray	134.7	141.0
Shale, dark gray, contains black carbonaceous material	141.0	142.0
Shale, light to medium gray	142.0	193.4
Howard Formation:		
Shale, light gray, interbedded with hard limy zones.	193.4	196.3
Limestone, dark bluish gray, irregular crystalline, contains brachiopods, crinoids, algal material, and "black inclusions"	196.3	197.5
Severy Formation:		
Shale, black	197.5	198.0
Shale, light gray	198.0	198.5
Shale, black	198.5	199.0
Shale, light gray	199.0	203.0
Coal, black	203.0	203.1
Shale, medium gray	203.1	208.3
Shale, medium gray, interbedded with hard limy zones	208.3	210.0
Shale, medium gray	210.0	211.6
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray, very finely crystalline, contains brachiopods and crinoids	211.6	212.0

Test Hole #7-79
Otoe County

Location: SE corner sec. 5, T. 9 N., R. 13 E., approximately 18 feet north of south section line and 61 feet west of east section line.
Ground elevation: 1,058.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	2.0
Silt, light brown, clayey	2.0	22.0
Sand, very fine to medium	22.0	47.0
Sand, very fine to very coarse	47.0	83.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, medium to dark gray	83.5	90.0
Shale, olive gray	90.0	94.0
Shale, varicolored, yellow, green, brown, and gray	94.0	97.0
Shale, pale yellow	97.0	102.5
Limestone, yellowish brown, very finely crystalline	102.5	103.5
Shale, pale olive	103.5	108.0
Wakarusa Formation:		
Limestone, dark gray, very finely crystalline, contains crinoids	108.0	110.0
Soldier Creek Formation:		
Shale, light gray	110.0	114.8
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, very finely crystalline	114.8	116.2
Winnebago Member:		
Shale, light gray	116.2	121.2
Shale, olive	121.2	122.5
Shale, light to medium gray	122.5	138.5
Taylor Branch Member:		
Limestone, medium to dark gray, very finely crystalline, contains brachiopods and algal material, interbedded with shale, gray	138.5	140.0
Scranton Formation:		
Cedarvale - White Cloud Members:		
Shale, pale reddish gray	140.0	141.0
Shale, medium gray	141.0	142.0
Shale, dark olive gray	142.0	151.5
Shale, dark greenish gray	151.5	160.3
Shale, reddish gray	160.3	167.0
Shale, reddish brown	167.0	168.0
Shale, greenish gray	168.0	169.0
Shale, medium to dark gray	169.0	174.0
Shale, light to medium gray	174.0	226.5

Howard Formation:		
Limestone, tannish gray, very finely crystalline, contains brachiopods, crinoids, pyrite and "black inclusions".....	226.5	230.7
Severy Formation:		
Shale, black, contains carbonaceous material.....	230.7	231.4
Shale, light gray.....	231.4	232.0

Test Hole #10-79
Otoe County

Location: NE corner sec. 5, T. 9 N., R. 13 E., approximately 90 feet south of north section line and 24 feet west of east section line.
Ground elevation: 1,064.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	1.0
Silt, pale brown, clayey	1.0	17.0
Silt, light reddish brown, clayey, sandy	17.0	58.0
Sand, very fine to very coarse	58.0	103.5
Silt, medium gray, sandy	103.5	105.8
Sand, fine to coarse	105.8	115.0
Clay, dark gray	115.0	116.0
Silt, medium gray, sandy	116.0	122.0
Clay, medium gray, silty	122.0	135.4
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Howard Formation:		
Limestone, brown, irregular crystalline, contains crinoids, bryozoans, and algal material	135.4	137.3
Severy Formation:		
Shale, olive	137.3	138.7
Shale, medium gray	138.7	139.2
Shale, black	139.2	139.7
Shale, medium gray	139.7	145.5
Coal, black	145.5	145.7
Shale, medium gray	145.7	149.6
Shawnee Group:		
Calhoun - Topeka Formations:		
Coal Creek Member:		
Limestone, medium gray, finely crystalline, contains brachiopods	149.6	150.2
Shale, medium gray	150.2	152.3
Limestone, medium to dark gray, finely crystalline, contains brachiopods	152.3	155.1
Shale, dark gray	155.1	155.7
Limestone, dark gray, very finely crystalline, contains brachiopods	155.7	156.5
Holt Member:		
Shale, black	156.5	158.0
DuBois Member:		
Limestone, dark gray, very finely crystalline	158.0	160.2
Turner Creek Member:		
Shale, light gray to light greenish gray	160.2	162.0
Sheldon Member:		
Limestone, light tan, very finely crystalline, pseudo-oolitic, contains Osagia	162.0	165.5
Jones Point Member:		
Shale, light gray	165.5	167.0

Limestone, light gray, finely crystalline.....	167.0	169.0
Shale, light gray.....	169.0	169.8
Curzon - Calhoun Members:		
Limestone, light tan, finely crystalline, contains Osagia.....	169.8	172.9
Limestone, light tan, finely crystalline, contains crinoids, interbedded with shale, gray.....	172.9	174.0
Deer Creek Formation:		
Ervine Creek Member:		
Limestone, light tannish gray, very finely crystalline, contains brachiopods and crinoids.....	174.0	186.0
Limestone, light gray to dark brown, finely crystalline, contains brachiopods and fusulinids.....	186.0	196.5
Larsh Member:		
Shale, black, contains carbonaceous material.....	196.5	198.0
Rock Bluff Member:		
Limestone, tannish gray, very finely crystalline, contains pyrite.....	198.0	200.0

Test Hole #1-79
Otoe County

Location: NW NW SW sec. 6, T. 9 N., R. 13 E., approximately 394 feet south of half section line and 33 feet east of west section line.
Ground elevation: 1,048.5 ft. (Avoca 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	2.0
Clay, brown, silty	2.0	17.0
Silt, grayish brown, clayey	17.0	21.0
Silt, reddish brown, clayey	21.0	29.0
Silt, brownish gray, sandy	29.0	29.5
Sand, fine to very coarse, and gravel, very fine to fine	29.5	30.0
Pennsylvanian System - Virgil Series - Shawnee Group:		
Oread Formation:		
Kereford Member:		
Limestone, pale yellow, very finely crystalline, contains fusulinids and crinoids	30.0	34.0
Heumader Member:		
Shale, light gray	34.0	34.2
Plattsmouth Member:		
Limestone, pale yellow, very finely crystalline, contains fusulinids and crinoids	34.2	36.2
Shale, olive	36.2	36.4
Limestone, light tannish gray, finely crystalline, contains fusulinids	36.4	38.0
Shale, medium gray	38.0	38.7
Limestone, light gray to tannish gray, finely crystalline, contains brachiopods, crinoids, fusulinids, and coral, interbedded with shale, medium gray, thin	38.7	47.0
Heebner Member:		
Shale, medium gray	47.0	48.0
Shale, black	48.0	51.0
Leavenworth Member:		
Limestone, light bluish gray, very finely crystalline, contains brachiopods, fusulinids, and pyrite	51.0	52.9
Snyderville Member:		
Shale, light gray	52.9	54.0
Shale, light greenish gray	54.0	62.0
Shale, reddish brown	62.0	67.5
Shale, greenish gray	67.5	68.7
Toronto Member:		
Limestone, light tannish gray, very finely crystalline, pseudo-oolitic in part, contains brachiopods, crinoids, fusulinids, and Osagia, interbedded with shale, reddish brown and greenish gray	68.7	77.0

Test Hole #2-79
Otoe County

Location: NE NE NE SE sec. 6, T. 9 N., R. 13 E., approximately 130 feet south of half section line and 15 feet east of west section line.
Ground elevation: 1,068.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Clay, brown, silty	3.0	17.0
Clay, light brown, silty	17.0	27.0
Clay, light brown, silty, slightly sandy	27.0	34.0
Sand, very fine to fine, clayey	34.0	44.0
Silt, olive brown, sandy	44.0	51.0
Silt, gray	51.0	52.0
Silt, brown, clayey	52.0	53.0
Pennsylvanian System - Virgil Series - Shawnee Group:		
Topeka Formation:		
Sheldon Member:		
Limestone, light tan, finely crystalline, contains brachiopods and chert	53.0	54.0
Jones Point Member:		
Shale, pale yellow	54.0	57.0
Shale, light tan	57.0	60.0
Shale, pale olive	60.0	61.2
Curzon Member:		
Limestone, pale yellow, finely crystalline, contains brachiopods	61.2	65.6
Iowa Point Member:		
Shale, olive yellow	65.6	66.0
Hartford Member:		
Limestone, light brown, very finely crystalline, contains brachiopods	66.0	66.9
Calhoun Formation:		
Shale, light gray	66.9	68.3
Deer Creek - Tecumseh Formations:		
Ervine Creek Member:		
Limestone, light tan, very finely crystalline, contains brachiopods	68.3	72.5
Shale, pale olive	72.5	74.9
Limestone, light tannish gray, very finely crystalline, contains brachiopods, crinoids, fusulinids, bryozoans, and coral	74.9	83.8
Shale, black	83.8	84.0
Shale, olive gray	84.0	86.2
Limestone, olive gray, finely crystalline	86.2	87.0
Larsh Member:		
Shale, black, contains carbonaceous material	87.0	88.0

Rock Bluff Member:		
Limestone, tan, very finely crystalline, contains brachiopods and bryozoans	88.0	90.0
Oskaloosa - Rakes Creek Formations:		
Shale, olive gray	90.0	92.0
Siltstone, pale yellow to light tan	92.0	121.5
Shale, reddish brown	121.5	123.5
Ost Member:		
Limestone, light tannish gray, finely crystalline, interbedded with shale, pale olive	123.5	129.0
Shale, olive gray, interbedded with thin hard limy zones	129.0	133.0
Kenosha Member:		
Shale, medium gray	133.0	134.5
Lecompton Formation:		
Avoca Member:		
Limestone, medium gray, very finely crystalline, contains brachiopods	134.5	137.0

Test Hole #33-79
Otoe County

Location: NE NE SW sec. 6, T. 9 N., R. 13 E., approximately 250 feet south of half section line and 25 feet west of half section line.
Ground elevation: 1,050.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil, dark brown, silty, clayey.....	0.0	2.5
Silt, brown, clayey.....	2.5	5.0
Pennsylvanian System - Virgil Series - Shawnee Group:		
Oread Formation:		
Kereford Member:		
Limestone, yellowish brown, finely crystalline, highly weathered, contains abundant fusulinids....	5.0	8.0
Limestone, pale yellowish brown, finely crystalline, highly weathered, contains abundant fusulinids....	8.0	9.0
Limestone, light yellowish tan, finely crystalline, highly weathered, contains fusulinids and coral...	9.0	10.5
Heumader Member:		
Shale, olive.....	10.5	11.3
Plattsmouth Member:		
Limestone, light tannish gray, very finely crystalline, pseudo-oolitic, contains fusulinids and Osagia, cherty from 14.0 to 14.3 ft.....	11.3	15.0
Limestone, light tannish gray, very finely crystalline, pseudo-oolitic, contains Osagia.....	15.0	17.0
Limestone, light tannish gray, very finely crystalline, pseudo-oolitic, contains Osagia, fusulinids, and coral.....	17.0	19.5
Limestone, dark tannish gray, very finely crystalline, contains coral, fusulinids, crinoids, and algal material.....	19.5	23.0
Limestone, dark tannish gray, finely crystalline, contains crinoids and coral.....	23.0	24.0
Limestone, light gray, finely crystalline, shaly....	24.0	25.5
Heebner Member:		
Shale, olive.....	25.5	26.2
Shale, medium to dark gray.....	26.2	27.8
Shale, black.....	27.8	29.9
Leavenworth Member:		
Limestone, tannish gray, very finely crystalline, contains brachiopods.....	29.9	31.5
Snyderville Member:		
Shale, light gray.....	31.5	37.3
Shale, light gray with trace of red mottling at 39.5 ft.....	37.3	41.0
Shale, reddish brown.....	41.0	47.0

Toronto Member:		
Limestone, yellowish brown, finely crystalline, contains brachiopods, interbedded with shale, light gray, from 51.5 to 53.5 ft.....	47.0	53.5
Lawrence Formation:		
Shale, (no sample), probably reddish brown.....	53.5	57.5

Test Hole #34-79
Otoe County

Location: SW SW NW SE sec. 6, T. 9 N., R. 13 E., approximately 1,400 feet north of south section line and 2,650 feet west of east section line.
Ground elevation: 1,053.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	3.0
Silt, dark yellowish brown, clayey	3.0	5.0
Silt, brown, clayey, sandy	5.0	17.5
Silt, pale reddish brown	17.5	31.5
Sand, fine to very coarse, and gravel, fine	31.5	32.5
Silt, pale olive tan	32.5	35.5
Pennsylvanian System - Virgil Series - Shawnee Group:		
Deer Creek - Tecumseh Formations:		
Oskaloosa - Rakes Creek Members:		
Shale, olive	35.5	38.0
Shale, reddish brown	38.0	38.8
Ost Member:		
Limestone, olive yellow, finely crystalline	38.8	39.7
Limestone, olive tan, finely crystalline	39.7	41.4
Limestone, pale olive, finely crystalline, contains algal material	41.4	42.0
Shale, olive yellow	42.0	42.3
Shale, reddish brown	42.3	42.8
Shale, dark olive gray	42.8	43.4
Limestone, pale yellowish brown, finely crystalline, contains crinoids, interbedded with shale, yellow.	43.4	45.3
Kenosha Member:		
Shale, reddish brown	45.3	47.2
Shale, reddish gray with olive at bottom	47.2	49.3
Lecompton Formation:		
Avoca Member:		
Limestone, olive tan, very finely crystalline, contains brachiopods, crinoids, and coral	49.3	49.8
Shale, olive	49.8	50.4
Limestone, dark orangish brown, very finely to finely crystalline, contains brachiopods	50.4	51.0
Shale, olive with traces of black	51.0	51.8
Limestone, dark olive gray, finely crystalline, contains crinoids and brachiopods	51.8	52.9
King Hill Member:		
Shale, dark olive gray	52.9	54.7
Siltstone, olive gray	54.7	55.2
Shale, pale reddish brown	55.2	56.0
Shale, dark reddish brown	56.0	57.4
Shale, olive gray	57.4	57.9
Limestone, olive yellow to gray, finely crystalline.	57.9	58.3
Shale, olive gray	58.3	60.5

Limestone, light yellowish brown, finely crystalline, contains brachiopods	60.5	60.8
Shale, olive yellow	60.8	61.3
Beil Member:		
Limestone, light tan, finely crystalline, contains brachiopods and abundant crinoids	61.3	62.0
Limestone, light tan, very finely crystalline	62.0	63.5
Limestone, light tan, very finely crystalline, contains crinoids, interbedded with shale, olive yellow	63.5	65.0
Limestone, light tan, very finely to finely crystalline, contains coral, interbedded with shale, olive	65.0	67.0
Shale, olive yellow, interbedded with limestone, light tan	67.0	67.8
Limestone, light tan, very finely to finely crystalline, contains algal material, interbedded with shale, olive yellow	67.8	68.2
Queen Hill Member:		
Shale, light gray	68.2	70.3
Shale, black	70.3	70.9
Shale, dark gray	70.9	71.9
Shale, black	71.9	74.1
Big Springs Member:		
Limestone, olive tan, finely crystalline, contains brachiopods and algal material	74.1	75.3
Shale, olive, interbedded with limestone, olive, tan, finely crystalline	75.3	76.0
Doniphan Member:		
Shale, medium gray, interbedded with thin limestones from 78.0 to 78.7 feet	76.0	79.2
Shale, olive	79.2	80.6
Spring Branch Member:		
Limestone, light tan, very finely crystalline, pseudo-oolitic, contains Osagia and chert	80.6	84.0
Limestone, light tan, very finely crystalline, contains brachiopods and fusulinids	84.0	85.0
Shale, medium to dark gray, interbedded with limestone	85.0	87.0
Limestone, light gray, finely crystalline, contains crinoids and brachiopods	87.0	89.2
Kanwaka Formation:		
Stull Member:		
Shale, light gray	89.2	91.1
Clay Creek Member:		
Limestone, tan, very finely crystalline, pseudo-oolitic, contains Osagia	91.1	91.9
Jackson Park Member:		
Shale, olive	91.9	92.0

Oread Formation:		
Kereford Member:		
Limestone, yellowish orange, very finely to finely crystalline, contains fusulinids.....	92.0	93.8
Limestone, pale orange, very finely to finely crystalline, contains fusulinids and crinoids, cherty at 96.0 ft.....	93.8	97.7
Heumader Member:		
Shale, olive yellow.....	97.7	98.5
Plattsmouth Member:		
Limestone, very light tan, very finely to finely crystalline, contains abundant pseudo-oolites.....	98.5	100.0

Test Hole #35-79
Otoe County

Location: SW NE SW sec. 6, T. 9 N., R. 13 E., approximately 1,450 feet north of south section line and 1,100 feet west of east section line.
Ground elevation: 1,102.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	2.0
Silt, light brown, clayey	2.0	12.0
Silt, brown, clayey	12.0	16.0
Silt, pale reddish brown	16.0	23.0
Silt, yellow brown, sandy	23.0	32.0
Silt, orangish brown with iron staining, sandy	32.0	34.0
Silt, gray mottled with brown, sandy	34.0	43.0
Silt, brown, sandy	43.0	54.0
Clay, light tan, interbedded with silt, brown	54.0	62.0
Silt, tannish gray, clayey, sandy	62.0	78.0
Silt, gray	78.0	89.5
Silt, dark gray, clayey, sandy	89.5	92.0
Silt, olive	92.0	94.4
Sand and gravel	94.0	97.0
Silt, olive gray	97.0	100.0
Sand and gravel	100.0	101.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Howard Formation:		
Limestone, medium gray, finely crystalline	101.0	102.4
Shale, olive gray	102.4	102.6
Limestone, medium gray, finely crystalline, contains brachiopods	102.6	103.5
Shale, olive	103.5	103.8
Limestone, tannish gray, very finely crystalline, "speckled", contains brachiopods and algal material	103.8	105.5
Severy Formation:		
Shale, olive gray	105.5	105.7
Shale, black	105.7	106.4
Shale, medium gray	106.4	107.2
Shale, black	107.2	107.9
Shale, medium gray	107.9	113.6
Coal, black, interbedded with shale, black	113.6	114.4
Shale, medium gray	114.4	116.7
Limestone, medium gray, finely crystalline, interbedded with shale, gray	116.7	117.3
Shale, medium gray	117.3	117.8
Limestone, dark gray, finely crystalline	117.8	119.6

Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, medium to dark gray, very finely to finely crystalline, contains brachiopods, crinoids, and pyrite.....	119.6	121.8

Test Hole #37-79
Otoe County

Location: NE corner NW NE SW sec. 6, T. 9 N., R. 13 E., approximately 69 feet south of half section line and 700 feet west of east section line.
Ground elevation: 1,056.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil, reddish brown, silty, clayey	0.0	4.0
Soil, dark gray to black, silty, clayey	4.0	10.0
Soil, tan, silty, clayey	10.0	12.0
Silt, yellowish tan, sandy	12.0	16.0
Sand, medium to very coarse, and gravel, fine to medium, interbedded with silt, yellowish brown	16.0	25.5
Pennsylvanian System - Virgil Series - Shawnee Group:		
Lecompton Formation:		
Big Springs Member:		
Limestone, light to medium yellowish brown, finely crystalline, highly weathered, contains brachiopods	25.5	26.0
Doniphan Member:		
Shale, pale olive	26.0	29.0
Shale, light gray	29.0	29.5
Shale, pale olive	29.5	33.0
Spring Branch Member:		
Limestone, light tan mottled with yellowish brown, very finely to finely crystalline, pseudo-oolitic, contains algal material, Osagia, fusulinids, crinoids, and ostracods	33.0	34.0
Limestone, light yellowish brown to tan, very finely to finely crystalline, contains brachiopods, ostracods, Osagia, and abundant algal material	34.0	36.5
Shale, olive	36.5	36.8
Shale, medium gray	36.8	40.2
Shale, light gray	40.2	42.0
Kanwaka Formation:		
Shale, olive	42.0	43.1
Oread Formation:		
Kereford Member:		
Limestone, light gray, finely crystalline, shaly, contains brachiopods	43.1	44.2
Limestone, light tan, very finely crystalline, contains algal material	44.2	45.7
Limestone, yellowish tan, finely crystalline, contains brachiopods and algal material	45.7	47.0
Limestone, light tan with yellow tint, very finely to finely crystalline, contains crinoids and abundant fusulinids	47.0	50.0

Heumader Member:		
Shale, light olive gray.....	50.0	50.3
Plattsmouth Member:		
Limestone, tan, finely crystalline, contains fusulinids, Osagia, and abundant pseudo-oolites...	50.3	55.0
Limestone, medium yellowish tan, finely crystalline, contains brachiopods and pseudo-oolites.....	55.0	62.0
Limestone, medium yellowish tan, finely crystalline, impure, contains crinoids and fusulinids.....	62.0	63.7
Heebner Member:		
Shale, light gray.....	63.7	65.0
Shale, black, contains carbonaceous material.....	65.0	67.8
Leavenworth Member:		
Limestone, light tan with yellow iron staining, finely crystalline, contains crinoids and fusulinids.....	67.8	69.4
Snyderville Member:		
Shale, (no sample).....	69.4	70.0

Test Hole #38-79
Otoe County

Location: SE corner SW sec. 6, T. 9 N., R. 13 E., approximately 20 feet north of south section line and 152 feet west of half section line.
Ground elevation: 1,045.5 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil, dark brown, silty, clayey	0.0	4.0
Silt, brown, clayey	4.0	5.0
Silt, light brown, clayey	5.0	10.0
Silt, light brownish gray, clayey	10.0	16.5
Silt, pale reddish brown, clayey, sandy	16.5	22.0
Silt, very light tannish gray, clayey	22.0	30.0
Sand, medium to very coarse, and gravel, very fine to coarse	30.0	32.5
Silt, light tannish gray, clayey	32.5	35.0
Clay, light gray, silty	35.0	37.0
Clay, dark gray, silty	37.0	44.0
Clay, light gray, silty	44.0	47.5
Sand, fine to very coarse, and gravel, very fine to medium, contains limestone fragments	47.5	52.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
White Cloud Member:		
Shale, pale olive	52.0	56.5
Shale, dark gray with traces of olive mottling	56.5	62.0
Shale, medium gray	62.0	66.6
Howard Formation:		
Limestone, medium gray, very finely to finely crystalline, contains brachiopods, algal material, and abundant ostracods	66.6	68.2
Limestone, dark tannish gray, very finely to finely crystalline, contains brachiopods, algal material and abundant ostracods	68.2	70.6
Severy Formation:		
Shale, dark gray	70.6	71.0
Shale, black	71.0	72.0
Shale, medium gray	72.0	72.3
Shale, black	72.3	72.9
Shale, medium to light gray	72.9	79.5
Coal, black	79.5	80.1
Shale, light gray	80.1	81.7
Limestone, dark gray, finely crystalline	81.7	83.4
Shale, medium gray	83.4	84.8

Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray, finely crystalline.....	84.8	85.2
Limestone, medium gray, finely crystalline, contains fusulinids, and pyrite, interbedded with shale, dark gray, from 86.0 to 86.1 ft.....	85.2	87.2
Shale, dark gray.....	87.2	87.6
Limestone, medium to dark gray, finely crystalline, contains brachiopods and abundant crinoids.....	87.6	88.5
Shale, medium gray, limy.....	88.5	89.0
Limestone, medium gray, finely crystalline, contains crinoids and brachiopods.....	89.0	89.4
Holt Member:		
Shale, dark gray.....	89.4	90.1
Shale, black.....	90.1	91.3
DuBois Member:		
Limestone, medium to dark gray, finely crystalline, contains brachiopods and pyrite.....	91.3	91.8
Shale, medium to dark gray, limy.....	91.8	92.3
Limestone, light gray to light greenish gray, finely crystalline, shaly, contains crinoids.....	92.3	93.0
Turner Creek Member:		
Shale, light to medium gray.....	93.0	94.8
Sheldon Member:		
Limestone, very light tan, finely crystalline, pseudo-oolitic, contains Osagia, brachiopods, and gastropods.....	94.8	99.4
Jones Point - Iowa Point Members:		
Shale, light gray, interbedded with thin limestones.	99.4	102.0
Shale, medium gray, interbedded with thin limestones	102.0	103.5
Hartford Members:		
Limestone, very light gray, very finely to finely crystalline, contains crinoids, glauconite, and abundant fusulinids.....	103.5	105.5
Calhoun Formation:		
Shale, (no sample).....	105.5	105.6
Deer Creek - Tecumseh Formations:		
Ervine Creek Member:		
Limestone, very light tan, very finely to finely crystalline, contains gastropods.....	105.6	107.3
Limestone, light tannish gray, very finely to finely crystalline, contains brachiopods, algal material, and bryozoans.....	107.3	111.0
Limestone, very light gray to white, very finely crystalline, contains coral, fusulinids and pyrite	111.0	115.4
Limestone, dark tannish gray, finely crystalline, contains crinoids and fusulinids.....	115.4	121.1
Shale, medium to dark gray, hard, contains fusulinids and crinoids.....	121.1	121.9
Limestone, light to medium gray, finely crystalline, contains crinoids.....	121.9	123.3

Shale, medium gray	123.3	124.6
Limestone, light gray, finely crystalline, contains crinoids	124.6	125.3
Larsh Member:		
Shale, medium gray	125.3	125.8
Shale, dark gray to black	125.8	126.4
Rock Bluff Member:		
Limestone, medium tan, very finely crystalline, contains brachiopods and fusulinids	126.4	129.2
Oskaloosa - Rakes Creek Members:		
Shale, medium gray	129.2	131.6
Silt, light bluish gray	131.6	142.0
Silt, light bluish gray, interbedded with sandstone, light bluish gray, from 143.0 to 144.0 ft	142.0	147.0
Silt, light bluish gray, interbedded with sandstone, light bluish gray, at 151.6 ft	147.0	157.0
Shale, medium to light gray	157.0	158.5
Shale, reddish brown	158.5	161.3
Ost Member:		
Limestone, light gray to light greenish gray, very finely to finely crystalline, interbedded with shale, reddish brown	161.3	164.5
Shale, pale reddish gray, interbedded with thin limy zones	164.5	165.0
Limestone, very light greenish gray, finely crystalline, shaly	165.0	165.8
Kenosha Member:		
Shale, reddish brown with traces of gray to greenish gray	165.8	169.0
Shale, gray to greenish gray with traces of reddish brown	169.0	170.0
Lecompton Formation:		
Avoca Member:		
Limestone, tannish gray, finely crystalline, shaly, contains crinoids	170.0	171.2
Limestone, dark gray, finely crystalline, shaly, contains crinoids and fusulinids	171.2	171.4
Limestone, medium gray, finely crystalline, contains crinoids and fusulinids	171.4	174.0
King Hill Member:		
Shale, medium gray	174.0	175.0
Shale, reddish brown	175.0	177.5
Limestone, brown, finely crystalline, shaly	177.5	178.0
Shale, greenish gray	178.0	180.3
Beil Member:		
Limestone, light tan, very finely crystalline, pseudo-oolitic in part, contains Osagia, algal material, and fusulinids	180.3	183.3
Limestone, light tan, very finely crystalline, contains pyrite, brachiopods, and crinoids, interbedded with shale, greenish gray	183.3	185.0
Limestone, light tan, very finely crystalline, contains crinoids, brachiopods, fusulinids and pyrite	185.0	187.4

Queen Hill Member:		
Shale, light gray	187.4	188.0
Shale, dark gray	188.0	189.0
Shale, black, contains carbonaceous material	189.0	192.3
Big Springs Member:		
Limestone, tannish gray, very finely to finely crystalline, impure, contains fusulinids, crinoids, and brachiopods	192.3	194.1
Doniphan Member:		
Shale, light to medium gray, interbedded with thin limy zones at 195.0 and 196.0 ft	194.1	197.0
Spring Branch Member:		
Limestone, light tank, finely crystalline, contains crinoids and algal material, interbedded with shale, greenish gray	197.0	198.3
Limestone, light gray, very finely crystalline, contains crinoids, algal material, and glauconite	198.3	202.6
Shale, dark gray	202.6	203.4
Shale, light gray, limy	203.4	204.6
Kanwaka Formation:		
Stull Member:		
Shale, light gray	204.6	206.0
Clay Creek Member:		
Limestone, medium gray, finely crystalline, shaly, contains crinoids and abundant brachiopods	206.0	206.7
Jackson Park Member:		
Shale, medium gray	206.7	207.8
Oread Formation:		
Kereford Member:		
Limestone, light gray to tannish gray, finely crystalline, contains ostracods	207.8	209.7
Limestone, very light tan, very finely crystalline, contains fusulinids, ostracods, pyrite, and glauconite	209.7	212.0
Limestone, very light gray to white, very finely to finely crystalline, contains brachiopods, pyrite, and abundant fusulinids	212.0	215.2
Heumader Member:		
Shale, light gray, limy	215.2	215.5
Plattsmouth Member:		
Limestone, light gray to very light tan, very finely to finely crystalline, pseudo-oolitic, contains fusulinids and chert	215.5	219.8
Limestone, medium gray to tannish gray, finely crystalline, contains chert and abundant fusulinids	219.8	223.0
Limestone, tannish gray, finely crystalline, impure, contains abundant fusulinids and abundant algal material	223.0	227.0
Limestone, tannish gray, finely crystalline, contains crinoids, glauconite, and "black inclusions"	227.0	229.8

Heebner Member:		
Shale, medium gray	229.8	231.9
Shale, black	231.9	233.9
Leavenworth Member:		
Limestone, medium tannish gray, very finely crystalline, contains fusulinids, crinoids, brachiopods, gastropods, and "black inclusions"	233.9	235.7
Snyderville Member:		
Shale, light gray	235.7	242.0
Shale, light greenish gray	242.0	244.5
Shale, reddish brown	244.5	250.4
Toronto Member:		
Limestone, very light tan to white, very finely crystalline, contains brachiopods, algal material, chert, and pyrite	250.4	257.5
Limestone, very light tan to white, very finely crystalline, contains fusulinids, interbedded with shale, gray, greenish gray, and reddish brown	257.5	260.0
Douglas Group:		
Lawrence Formation:		
Shale, light gray	260.0	262.0
Shale, reddish brown	262.0	273.0
Shale, varicolored, reddish brown, gray, and greenish gray	273.0	278.5
Shale, medium gray	278.5	294.0
Shale, black	294.0	294.5
Shale, medium gray	294.5	303.6
Cass Formation:		
Haskell Member:		
Limestone, medium gray, finely crystalline, impure, contains crinoids, brachiopods, and abundant fusulinids	303.6	306.6
Little Pawnee Member:		
Shale, medium gray	306.6	307.5
Shale, black	307.5	308.3
Shoemaker Member:		
Limestone, dark gray, finely crystalline, contains brachiopods, crinoids, and fusulinids	308.3	309.4
Plattford Formation:		
Unnamed Member:		
Shale, light to medium gray	309.4	311.0
Shale, light gray to light greenish gray	311.0	311.6
Shale, reddish brown	311.6	317.5
Nehawka Member:		
Limestone, very light tan, very finely crystalline, contains brachiopods and crinoids	317.5	324.0
Shale, (no sample)	324.0	325.2
Missouri Series - Lansing Group:		
Stanton Formation:		
South Bend Member:		
Limestone, very light tan, very finely crystalline, contains crinoids	325.2	326.6

Rock Lake Member:		
Shale, reddish brown, interbedded with limestone, very light tan	326.6	329.0
Limestone, very light tan, very finely crystalline, contains fusulinids and brachiopods	329.0	330.0
Shale, greenish gray interbedded with reddish brown and gray	330.0	332.0
Stoner Member:		
Limestone, very light gray to white, very finely crystalline, contains crinoids, fusulinids, bryozoans, and algal material	332.0	337.0
Limestone, very light greenish gray, very finely crystalline, contains brachiopods and crinoids	337.0	342.0
Limestone, very light greenish gray, very finely crystalline	342.0	347.0
Limestone, very light bluish gray, very finely crystalline, contains fusulinids	347.0	348.0
Shale, light greenish gray, limy	348.0	349.0
Limestone, light greenish gray, very finely crystalline, interbedded with shale, light greenish gray.	349.0	352.9
Eudora Member:		
Shale, greenish gray, interbedded with limestone, light greenish gray, very finely crystalline	352.9	354.3
Captain Creek Member:		
Limestone, greenish gray, finely crystalline, interbedded with shale, greenish gray	354.3	355.6
Vilas Formation:		
Shale, greenish gray	355.6	356.0
Limestone, greenish gray, finely crystalline, contains crinoids, interbedded with shale, greenish gray	356.0	357.0
Shale, black	357.0	357.4
Shale, reddish brown	357.4	359.0
Shale, greenish gray	359.0	359.1
Limestone, light tan, very finely crystalline, contains brachiopods	359.1	359.7
Shale, dark gray to black	359.7	360.0
Shale, medium gray	360.0	362.0
Shale, greenish gray to medium gray	362.0	362.3
Plattsburg Formation:		
Limestone, very light tan with greenish tint, very finely to finely crystalline, contains fusulinids and gastropods	362.3	366.7
Shale, light greenish gray, limy	366.7	368.0
Limestone, very light gray, very finely crystalline.	368.0	371.5
Kansas City Group:		
Bonner Springs Formation:		
Shale, light bluish gray to greenish gray	371.5	376.5
Wyandotte Formation:		
Farley Member:		
Limestone, light tan, very finely to finely crystalline, contains crinoids, fusulinids, and algal material	376.5	377.0

Shale, light greenish gray, limy.....	377.0	377.6
Limestone, very light tan, very finely crystalline, contains pyrite.....	377.6	383.2
Limestone, very light tan, very finely crystalline, interbedded with shale, light greenish gray.....	383.2	388.3
Island Creek Member:		
Limestone, light tan to light greenish gray, very finely crystalline, interbedded with shale, greenish gray to white.....	388.3	390.0
Argentine Member:		
Limestone, light tan to white, very finely to finely crystalline.....	390.0	407.0
Limestone, very light tan to white, very finely crystalline, contains fusulinids and pyrite.....	407.0	415.4
Quindara Member:		
Shale, dark gray to black.....	415.4	416.9
Frisbie Member:		
Limestone, (electric log).....	416.9	418.2
Lane Formation:		
Shale, dark greenish gray, interbedded with thin limestone seams.....	418.2	436.0
Iola Formation:		
Limestone, shaly, (electric log).....	436.0	438.5
Limestone, light tannish gray to white with light greenish gray tint, very finely crystalline, contains algal material.....	438.5	443.5
Shale, (electric log).....	443.5	444.5
Limestone, (electric log).....	444.5	445.5
Chanute Formation:		
Shale, greenish gray.....	445.5	451.5
Drum Formation:		
Limestone interbedded with shale (electric log).....	451.5	467.5
Quivera Formation:		
Shale, (electric log).....	467.5	473.5
Sarpy Formation:		
Westerville Member:		
Limestone, (electric log).....	473.5	483.5
Fontana Formation:		
Shale, (electric log).....	483.5	490.8
Dennis Formation:		
Winterset Member:		
Limestone, (electric log).....	490.8	500.0

Test Hole #9-79
Otoe County

Location: SW corner SE sec. 7, T. 9 N., R. 13 E., approximately 15 feet north of south section line and 56 feet east of half section line.
Ground elevation: 1,120.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	2.5
Silt, light brown, clayey	2.5	12.0
Sand, very fine to fine, clayey, silty	12.0	17.0
Silt, reddish brown	17.0	24.0
Silt, yellowish brown	24.0	37.0
Silt, beige, sandy	37.0	48.0
Silt, light to dark brown, clayey, sandy	48.0	70.0
Silt, light to medium gray, clayey, sandy	70.0	160.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Cedarvale - White Cloud Members:		
Shale, dark gray	160.0	172.0
Shale, medium to dark gray	172.0	181.0
Shale, light gray	181.0	183.5
Shale, medium to dark gray	183.5	189.0
Shale, light gray	189.0	190.0
Howard Formation:		
Limestone, medium gray to tannish gray, very finely crystalline, contains brachiopods, algal material, pyrite, and "black inclusions"	190.0	194.1
Severy Formation:		
Shale, light gray	194.1	194.6
Shale, black	194.6	195.3
Shale, light gray	195.3	195.7
Shale, black	195.7	196.4
Shale, light gray	196.4	202.8
Coal, black	202.8	203.3
Shale, light gray, sandy	203.3	206.0

Test Hole #5-79
Otoe County

Location: NW SW NW NW sec. 8, T. 9 N., R. 13 E., approximately 770 feet south of north section line and 20 feet east of west section line.
Ground elevation: 1,090.5 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: no sample	0.0	2.0
Silt, light tan, clayey	2.0	10.0
Silt, reddish brown	10.0	40.0
Silt, light olive, clayey	40.0	41.0
Sand, very fine to fine	41.0	77.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
White Cloud Member:		
Shale, olive gray	77.0	78.0
Shale, medium to dark gray	78.0	82.0
Shale, olive gray	82.0	85.0
Shale, greenish gray	85.0	87.0
Howard Formation:		
Shale, greenish gray, interbedded with hard limy zones	87.0	90.4
Limestone, dark tan, very finely crystalline	90.4	91.5
Severy Formation:		
Shale, olive	91.5	93.0
Shale, medium gray	93.0	93.3
Shale, olive	93.3	100.0
Shale, black, contains carbonaceous material	100.0	101.0
Shale, olive gray	101.0	106.3
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray, very finely crystalline	106.3	108.6
Shale, medium gray	108.6	109.0
Limestone, light gray, finely crystalline, contains crinoids	109.0	110.0
Holt Member:		
Shale, dark gray	110.0	112.0
Shale, black	112.0	112.5
DuBois Member:		
Limestone, dark gray, finely crystalline, contains brachiopods and bryozoans	112.5	113.8
Turner Creek Member:		
Shale, light greenish gray	113.8	115.5
Sheldon Member:		
Limestone, light tan, finely crystalline, contains brachiopods and algal material	115.5	118.8
Jones Point Member:		
Shale, light gray	118.8	121.5

Curzon Member:		
Limestone, light tan, irregular crystalline, contains brachiopods, crinoids, and algal material...	121.5	124.5
Iowa Point Member:		
Shale, medium gray.....	124.5	124.9
Hartford Member:		
Limestone, light gray, finely crystalline.....	124.9	126.0
Calhoun Formation:		
Shale, light gray.....	126.0	126.3
Deer Creek - Tecumseh Formations:		
Limestone, light tan, finely crystalline, contains brachiopods, crinoids and algal material.....	126.3	142.4
Shale, medium gray.....	142.4	142.5
Limestone, light tan, finely crystalline, contains algal material and crinoids.....	142.5	144.5
Shale, dark gray.....	144.5	145.5
Limestone, light gray, finely crystalline, contains brachiopods and crinoids.....	145.5	146.5
Larsh Member:		
Shale, black.....	146.5	147.7
Rock Bluff Member:		
Limestone, tan, very finely crystalline, contains pyrite.....	147.7	150.0
Oskaloosa - Rakes Creek Members:		
Shale, medium gray.....	150.0	151.0
Shale, light bluish gray.....	151.0	156.0
Siltstone, light bluish gray.....	156.0	179.5
Shale, olive gray.....	179.5	181.5
Shale, reddish brown.....	181.5	182.5

Test Hole #8-79
Otoe County

Location: SW NW NW NW sec. 8, T. 9 N., R. 13 E., approximately 495 feet south of north section line and 21 feet east of west section line.
Ground elevation: 1,076.5 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Silt, tannish yellow, clayey	0.0	4.0
Sand, very fine, silty	4.0	11.0
Clay, yellowish tan, silty	11.0	17.0
Sand, very fine to fine	17.0	58.0
Silt, medium gray, sandy	58.0	62.0
Sand, very fine, silty	62.0	77.0
Silt, medium gray, clayey	77.0	127.5
Silt, medium gray, sandy	127.5	133.5
Sand, medium to very coarse, and gravel, very fine to medium, clayey, silty	133.5	138.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Cedarvale - White Cloud Members:		
Shale, olive gray	138.0	139.0
Shale, medium gray	139.0	173.0
Limestone, light gray, finely crystalline, contains crinoids, brachiopods, and algal material	173.0	174.5
Shale, medium gray	174.5	183.7
Howard Formation:		
Limestone, light to medium gray, finely crystalline, contains brachiopods, algal material, pyrite, and "black inclusions"	183.7	188.1
Severy Formation:		
Shale, medium gray	188.1	188.6
Shale, black, contains carbonaceous material	188.6	189.1
Shale, medium gray	189.1	189.6
Shale, black	189.6	190.0
Shale, medium gray	190.0	196.6
Coal, black	916.6	197.0
Shale, medium gray	197.0	199.1
Limestone, dark gray, very finely crystalline	199.1	199.6
Shale, dark gray	199.6	201.7
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, dark gray, very finely crystalline, contains brachiopods, crinoids, and pyrite	201.7	206.0
Holt Member:		
Shale, black, contains carbonaceous material	206.0	207.0
DuBois Member:		
Limestone, dark tannish gray, very finely crystalline, contains brachiopods and crinoids	207.0	208.3

Turner Creek Member:		
Shale, light gray to greenish gray.....	208.3	209.5
Sheldon Member:		
Limestone, light tan to white, very finely crystalline.....	209.5	214.7
Jones Point Member:		
Limestone, light tan, very finely crystalline, contains brachiopods, crinoids and fusulinids.....	214.7	218.0
Shale, light gray.....	218.0	219.0
Curzon Member:		
Limestone, light tan, very finely crystalline, contains brachiopods, crinoids, and chert.....	219.0	222.0
Iowa Point Member:		
Shale, black.....	222.0	222.1
Shale, medium gray, interbedded with hard limy zones	222.1	223.0
Hartford Member:		
Limestone, light tannish gray, very finely crystalline, contains algal material.....	223.0	224.0
Calhoun Formation:		
Shale, light gray.....	224.0	225.0
Deer Creek Formation:		
Ervine Creek Member:		
Limestone, very light tan, very finely crystalline, contains brachiopods, crinoids, and algal material	225.0	232.0
Shale, light gray.....	232.0	233.0
Limestone, light gray, very finely crystalline, contains crinoids.....	233.0	234.1
Limestone, dark tan, very finely crystalline, contains brachiopods and algal material.....	234.1	240.0

Test Hole #1-A-66
Otoe County

Location: NE corner sec. 10, T. 9 N., R. 13 E., approximately 222 feet south of north section line and 13 feet west of east section line.
Ground elevation: 1,061.0 ft. (Nehawka 7.5 min. quadrangle)
Depth to water: 34.44 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Silt, moderately clayey, dark brownish gray, below 0.5 ft. grayish brown	0.0	5.0
Silt, moderately clayey, sandy, brownish gray	5.0	10.0
Silt, moderately clayey, light olive brown, some olive, some ironstone and iron stain	10.0	20.0
Silt, moderately clayey, moderately sandy, yellowish brown, sand is very fine to fine, some iron stain, below 23.5 ft. very sandy, sand is very fine to medium, some coarse	20.0	27.3
Silt, moderately clayey, some sand grains, light olive gray, some light gray, some iron stain	27.3	35.0
Silt, very clayey, sandy, light yellowish brown, some pale brown, sand is very fine to medium, some iron stain	35.0	45.5
Sand, very silty, sand is very fine to medium	45.5	48.5
Silt, very sandy, slightly clayey, light gray, sand is very fine to medium, below 50.0 ft. pale brown.	48.5	60.0
Silt, slightly clayey, sandy, light gray, sand is very fine to medium, below 64.5 ft. pale brown, below 65.5 ft. some fine gravel	60.0	68.0
Silt, moderately clayey, sandy, light gray, sand is very fine to medium, below 69.0 ft. slightly calcareous, dark gray	68.0	75.0
Silt, moderately clayey, sandy, moderately calcareous, olive gray, sand is very fine, from 95.0 to 102.7 ft. slightly calcareous, some limestone fragments below 102.7 ft	75.0	107.0
Silt, clayey, light olive gray, below 111.0 ft. slightly calcareous, reddish gray	107.0	116.0
Silt, moderately clayey, sandy, gray, below 121.0 ft. olive gray	116.0	122.5
Silt, clayey, sandy, slightly calcareous, light greenish gray	122.5	128.0
Sand and gravel, fine sand to coarse gravel, principally reworked sandstone fragments	128.0	129.1
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, medium olive mottled with light gray, clayey, slightly calcareous	129.1	130.0
Shale, light yellowish brown, clayey, silty, moderately calcareous	130.0	132.5
Shale, gray, clayey, slightly calcareous	132.5	134.5

Limestone, medium gray, earthy, fossiliferous, contains crinoids	134.5	135.0
Limestone, medium gray, very finely crystalline	135.0	135.7
Shale, light gray, silty, very calcareous	135.7	136.4
Shale, medium gray, clayey, slightly calcareous	136.4	139.4
Wakarusa Formation:		
Limestone, medium gray, finely crystalline, contains crinoids and interbedded medium gray shale seams	139.4	140.4
Shale, medium gray, silty, very calcareous	140.4	140.8
Limestone, medium gray, finely crystalline, contains abundant crinoids	140.8	142.4
Soldier Creek Formation:		
Shale, medium gray, silty with interbedded thin medium gray limestone	142.4	143.7
Shale, medium gray, clayey, slightly calcareous	143.7	146.0
Shale, medium greenish gray, silty, slightly calcareous	146.0	146.3
Shale, dark reddish brown, clayey, very slightly calcareous	146.3	148.3
Burlingame Formation:		
South Fork Member:		
Limestone, light gray, very finely crystalline, contains glauconite, crinoids and light greenish gray shale seams	148.3	149.6
Shale, light greenish gray, silty, very calcareous	149.6	149.8
Shale, dark reddish brown and light greenish gray mottled, very calcareous	149.8	150.1
Winnebago Member:		
Shale, reddish brown, silty	150.1	151.6
Shale, pale olive, sandy	151.6	153.8
Shale, light greenish gray, sandy, very slightly calcareous	153.8	155.0
Shale, medium gray, silty, slightly calcareous	155.0	160.0
Shale, medium gray, clayey	160.0	171.5
Shale, dark gray with dark limestone seams	171.5	172.0
Taylor Branch Member:		
Limestone, medium gray, very finely crystalline	172.0	172.5
Shale, light greenish gray, silty, very calcareous	172.5	174.8
Shale, dark reddish brown, silty, moderately calcareous	174.8	176.1
Shale, medium greenish gray	176.1	176.7
Limestone, medium gray, very finely crystalline with light greenish gray shale seams	176.7	178.1
Scranton Formation:		
Shale, light greenish gray with some yellowish brown mottling, clayey, slightly calcareous	178.1	178.5
Shale, yellowish brown mottled with greenish gray, clayey, very slightly calcareous	178.5	179.0
Shale, medium gray, clayey, very slightly calcareous	179.0	189.1
Shale, light greenish gray, silty, slightly sandy, slightly calcareous	189.1	190.5

Test Hole #4-N-43
(A9-13-23dc)
Otoe County

Location: C SL sec. 23, T. 9 N., R. 13 E., approximately one-half mile west of southeast corner.
Ground elevation: 1,150.0 ft. (Nebraska City NW 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Clay, very silty, medium yellowish gray with some dark brownish gray.....	0.0	9.0
Clay, very silty, to silt, very clayey, light and medium yellowish gray.....	9.0	19.0
Silt, moderately to very clayey, light yellowish gray with some light brownish yellow, slightly less clayey below 24.0 ft.....	19.0	29.0
Clay, very silty, to silt, very clayey, in part sandy, in part slightly calcareous, light and medium yellowish gray, possibly till below 34.0 ft.....	29.0	36.0
Sand, quartz and pink silicates with some limestone grains, texture grades from fine to coarse with a little very coarse sand, contains many limestone grains below 54.0 ft., and a trace of fine gravel, contains very few feldspar grains from 54.0 to 59.0 ft., and below 79.0 ft., contains some silt, moderately clayey, white to very light gray from 79.0 to 84.0 ft.....	36.0	84.0
Silt, moderately clayey, very light gray, slightly to in part moderately calcareous.....	84.0	99.0
Till: clay, very silty to slightly sandy, moderately calcareous, brownish gray and medium gray, may contains some sand layers.....	99.0	139.0

Test Hole #3-B-66
Otoe County

Location: NE NE SW sec. 23, T. 9 N., R. 13 E., approximately 2,490 feet north of south section line and 2,630 feet east of west section line.
Ground elevation: 1,151.0 ft. (Nebraska City NW 7.5 min. quadrangle)
Depth to water: 125.58 ft.

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Road fill	0.0	0.5
Silt, moderately clayey, sandy, olive brown, sand is very fine	0.5	10.0
Silt, moderately clayey, sandy, yellowish brown, sand is very fine, from 15.0 to 17.5 ft. sand is very fine to fine	10.0	18.0
Sand, silty, sand is very fine to coarse	18.0	19.8
Till: clay, silty, sandy, gravelly, light olive brown, below 20.0 ft. pale olive	19.8	20.5
Sand, silty, sand is fine to medium, some gravel	20.5	22.5
Silt, moderately clayey, sandy, olive yellow, sand is fine	22.5	25.0
Sand, silty, slightly clayey, sand is fine	25.0	27.5
Silt, sandy, moderately clayey, olive yellow, sand is coarse	27.5	30.0
Sand, silty, moderately clayey, coarse sand to gravel	30.0	38.0
Silt, moderately clayey, light olive brown, trace of fine to coarse sand	38.0	40.0
Sand, silty, sand is fine to coarse, below 45.0 ft. coarser grained, less silt than above	40.0	55.0
Sand, medium to coarse, with some gravel grains, no gravel grains below 75.0 ft., silty	55.0	81.5
Silt, clayey, sandy, slightly calcareous, pale olive, sand is very fine, some iron stain	81.5	95.0
Sand, fine to coarse, from 100.0 to 105.0 ft. trace of fine gravel	95.0	130.0
Sand, fine to coarse, trace of fine gravel	130.0	154.5
Silt, moderately clayey, sandy, pale olive, sand is very fine to fine, from 155.0 to 156.0 ft. gray, below 156.0 ft. dark olive gray	154.5	158.0
Clay, silty, dark olive gray, trace of very fine sand, from 160.0 to 160.5 ft. dark gray, below 160.5 ft. gray	158.0	163.5
Clay, silty, olive gray	163.5	164.9
Chert	164.9	165.3
Limestone, pale gray, cherty, shaly	165.3	166.5
Shale, clayey, slightly calcareous, gray to grayish brown	166.5	170.0
Silt, sandy, greenish gray, some iron stain and sandstone fragments	170.0	176.0

Silt, sandy, pale brown, some iron stain and sandstone fragments, from 177.0 to 177.5 ft. grayish brown, below 177.5 ft. yellowish brown.....	176.0	180.9
Silt, sandy, brownish gray, below 183.1 ft. yellowish brown, some iron stain and sandstone fragments	180.9	186.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, light gray, silty.....	186.5	187.1
Shale, medium gray, silty.....	187.1	189.5
Shale, medium gray, clayey.....	189.5	196.8
Limestone, dark gray, very finely crystalline, shaly, contains brachiopods and crinoids.....	196.8	198.8
Shale, light gray, moderately hard, silty, slightly calcareous.....	198.8	204.3
Shale, dark reddish brown, silty, slightly calcareous.....	204.3	204.9
Limestone, light gray, very finely crystalline, with light greenish gray shale seams.....	204.9	206.3
Shale, medium greenish gray mottled with dark gray, silty, moderately calcareous.....	206.3	209.2
Shale, medium greenish gray mottled with some pink, contains limy lenses.....	209.2	211.7
Shale, light greenish gray with some pink mottling, silty, slightly calcareous.....	211.7	212.0
Shale, dark reddish brown, some light greenish gray mottling, silty, slightly calcareous.....	212.0	215.0
Shale, light greenish gray, silty, moderately calcareous.....	215.0	216.0
Emporia Formation:		
Elmont Member:		
Limestone, light gray, very finely crystalline, contains abundant crinoids and some brachiopods with interbedded light greenish gray shale seams.....	216.0	217.7
Harveyville Member:		
Shale, medium greenish gray, silty, moderately calcareous.....	217.7	219.5
Reading Member:		
Shale, light greenish gray with some dark reddish brown mottling.....	219.5	219.7
Limestone, very light gray, very finely crystalline, shaly, contains glauconite, crinoids, Osagia with interbedded light greenish gray shale seams.....	219.7	221.5
Limestone, medium gray, finely crystalline, contains crinoids and brachiopods.....	221.5	222.8
Auburn Formation:		
Shale, medium gray, silty, contains some thin limestone seams.....	222.8	223.3
Shale, light greenish gray, hard, non-calcareous....	223.3	227.0
Shale, dark reddish brown, silty, slightly calcareous.....	227.0	230.0

Test Hole #2-A-47
(A9-13-36ad)
Otoe County

Location: NE NE sec. 36, T. 9 N., R. 13 E., approximately 850 feet south and 1,320 feet west of northeast corner.
Ground elevation: 1,025.0 ft. (Nebraska City NW 7.5 min. quadrangle)
Depth to water: 21.4 ft.

	Depth, in feet	
	From	To
Quaternary System, undifferentiated:		
Soil: silt, sandy, medium to dark brown, contains very fine to fine sand	0.0	1.0
Silt, very clayey, to clay, very silty, medium brown	1.0	8.5
Silt, very sandy, to sand, very silty, light brownish gray, texture of sand grades from very fine to medium	8.5	13.0
Clay, silty, light gray and light brownish gray, contains some mottled brownish yellow	13.0	21.0
Silt, moderately clayey, dark gray	21.0	23.0
Silt, clayey to sandy, contains very fine to fine sand, contains some very sandy layers	23.0	36.0
Sand, medium gray, texture grades from fine to coarse with some very coarse sand to fine gravel	36.0	39.0
Sand, silty, medium gray, texture of sand grades from very fine to medium	39.0	40.0
Sand, medium gray, texture grades from fine to coarse with some very coarse sand to fine gravel, contains some medium gravel and limestone pebbles below 45.5 ft	40.0	47.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Shale, clayey, maroon	47.0	49.0

Test Hole #1-T-35
(A9-14-31ac)
Otoe County

Location: NW SW NE sec. 31, T. 9 N., R. 14 E., approximately 2,000 feet south and 2,200 feet west of northeast corner.
Ground elevation: 927.0 ft. (Nebraska City NW 7.5 min. quadrangle)
Depth to water: unknown

	Depth, in feet From	To
Quaternary System, undifferentiated:		
Soil: silt, sand and gravel.....	0.0	10.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Soldier Creek - Burlingame Formations:		
Shale, sandy, bluish gray.....	10.0	16.0
Sandstone, argillaceous, fine-grained, light bluish gray.....	16.0	27.0
Limestone, light gray.....	27.0	28.0
Shale, argillaceous, dark bluish gray.....	28.0	30.5
Limestone, light gray, contains shale layer, calcareous, greenish gray from 32.5 to 33.0 ft.....	30.5	35.5
Scranton Formation:		
Shale, argillaceous, dark bluish gray, subfissile...	35.5	49.0
Shale, calcareous, light bluish gray.....	49.0	62.0
Sandstone, red, fine-grained.....	62.0	62.3
Shale, interbedded with sandstone, bluish gray.....	62.3	71.5
Shale, argillaceous to sandy, dark bluish gray.....	71.5	129.8
Howard Formation:		
Limestone, contains calcareous shale layer from 130.5 to 131.2 ft., and a calcareous shale layer with some argillaceous limestone from 131.8 to 133.0 ft.....	129.8	135.0
Severy Formation:		
Shale, dark gray to black, carbonaceous.....	135.0	141.5
Coal, (Nodaway).....	141.5	142.1
Shale, light bluish gray, calcareous hard layers at 144.1 and 144.8 ft.....	142.1	145.1
Shawnee Group:		
Topeka Formation:		
Limestone.....	145.1	145.3